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LETTER

FROM

THE SECRETARY OF THE NAVY,

TRANSMITTING,

In compliance with Senate resolution, February 2, 1886, report of National Academy of Sciences upon the proposed new Naval Observatory.

FEBRUARY 10, 1886.—Referred to the Committee on Naval Affairs and ordered to be printed.

NAVY DEPARTMENT,
Washington, February 9, 1886.

SIR: In compliance with the resolution of the Senate of the United States of the 2d instant, I have the honor to transmit herewith a copy of the report of the National Academy of Sciences, submitted in December last, upon the advisability of building a new Naval Observatory, and upon other subjects.

Very respectfully, your obedient servant,

W. C. WHITNEY,
Secretary of the Navy.

HON. JOHN SHERMAN,
President pro tempore United States Senate.

Prof. O. C. MARSH,
President of the National Academy of Sciences:

SIR: The undersigned, a committee appointed by you to consider and report upon certain matters concerning which the Secretary of the Navy has solicited the advice of the Academy, have attended to the duty assigned them, and respectfully report as follows:

The questions above referred to, as submitted by the Secretary to the Academy, are three, viz:

(1) As to the expediency of making the change in the time of beginning the astronomical day, recommended by the International Meridian Conference in 1884.

(2) As to the advisability of asking Congress to make an appropriation for the observation of the total eclipse of the sun to occur in August, 1886.

(3) As to the advisability of proceeding promptly with the erection of a new Naval Observatory upon the site purchased in 1880.

I. The Astronomical Day.

In regard to the first of the questions here presented, it appears to the undersigned that there are two points to be considered: first, how far the proposed change in the time of beginning the astronomical day is desirable in itself; and, secondly, whether, supposing it to be so, it is expedient to make the change in the American Ephemeris and Nautical Almanac forthwith, and without waiting for or soliciting the concurrent action of others.

The usage of astronomers, which makes noon instead of midnight the beginning of the day for their uses, was adopted without any reference to or thought of the purposes of general chronology, but was determined by the simple fact that the sun's meridian passage can be directly observed. Having been adopted, it has entered into all the literature of astronomical science from the time of Ptolemy down to the present day. It has, moreover, become inwrought into all the habits of thought of the astronomical and nautical world, while those who are neither navigators nor astronomers have so infrequent occasion to concern themselves with the computations of astronomy that the discrepancy between astronomical and civil reckoning is rarely brought to their attention, and by many is not even known to exist.

The proposed change is therefore not called for in order to remove any serious existing inconveniences; while, if made, it will be attended with the disadvantage of introducing an interruption of continuity between the astronomical records of the past and those of the future; so that the astronomers of coming centuries will be unable to make use of the tables and ephemerides heretofore constructed, without allowing for a difference of twelve hours.

It is true that the existing state of things may be a source of occasional uncertainty to the astronomer as to the exact date of a phenomenon reported to have taken place; as when, for instance, a remarkable comet or meteor may be said to have been observed on a given day between midnight and sunrise. During this period the astronomical and civil time dates differ by unit; and there may be doubt which of these times was intended; but this uncertainty will not exist in case the number of the hour as well as that of the day be stated, because in civil time the hour will be below twelve, and in astronomical time above.

It is an apparent objection to astronomical time reckoning that it divides the natural day—that is, the day between sunrise and sunset—into parts distinguished by different dates. For the ordinary purposes of life the natural day is a unit, and cannot be counted otherwise without confusion. The solar eclipse of August, 1886, for example, begins generally, upon the earth, by civil reckoning, in the morning of the 29th day of the month and ends in the afternoon of the same day; but by astronomical time it begins on the 28th and ends on the 29th. If this mode of counting dates should be extended to the record of historical events it is easy to see how great must be the consequent confusion.

But the fact that the discrepancy between the two different modes of time reckoning has not been felt as an important embarrassment in the astronomical world is evidenced by the almost absolute silence concerning it which characterizes the great mass of astronomical literature. The only astronomer of distinction by whom it is mentioned, so far as the knowledge of the committee extends, is Sir John Herschel, who, in his "Outlines of Astronomy," remarks, "This usage" (beginning the day at noon instead of midnight) "has its advantages and disadvantages, but the latter seem to be preponderate, and it would be well if,

in consequence, it could be broken through and the civil reckoning substituted."

While, however, the existence of the discrepancy under consideration cannot be regarded as a source of serious inconvenience, it must be admitted that in the interests of simplicity, it is desirable that it should disappear. The director of the Greenwich Observatory made early announcement of the purpose there to begin the change on the 1st of January, 1885, and though, in reply to a question from Commodore Franklin, Superintendent of our Naval Observatory, he stated, later, that this was "for internal use, awaiting official communication before introducing generally," it sufficiently indicates the preference of the astronomers at that establishment. Early in December, 1884, Commodore Franklin announced that the same change would be made at the Naval Observatory at the same date; but this order was subsequently withdrawn in deference to objections raised by Professor Newcomb, superintendent of the American Ephemeris. Immediately after this the expediency of the proposed change was submitted by a circular issued by Commodore Franklin to a large number of American astronomers, and the replies of nine out of eleven of these were favorable, the remaining two only giving a qualified dissent. This dissent relates not so much to the change itself as to the time of making it.

In view, then, of the general consensus of the astronomers of our own country in favor of the proposed change, and of the adhesion to the same view of so important an institution as the Royal Observatory of England, the committee are disposed to advise that the change should be made. The question follows, therefore, whether it is advisable to make the change, without further delay, in the American Ephemeris and Nautical Almanac, and other astronomical publications issued in this country, or whether it should be postponed until a general concurrence in the measure can be secured of the astronomical world elsewhere, in order that the change, when made, may be made simultaneously everywhere.

Arguments have been urged on both sides of this question. On the one hand it has been said that, inasmuch as the meridian conference was assembled on the call of the United States, there is a certain fitness in a prompt acquiescence on our part in the recommendations of that body. It has, moreover, been argued that our example would doubtless exercise an important influence in disposing favorably to the measure minds otherwise inclined to hesitate. Of the astronomers who expressed their opinions on this point, in answer to the circular issued by Commodore Franklin, the majority favored the immediate adoption of the mode of reckoning recommended by the Meridian Conference. The minority, however, objected to isolated action in a matter of such importance, arguing with apparent justice, that unnecessary confusion would be the consequence of the introduction of the change into different Ephemerides, at different dates. To this it has been added that the Ephemerides prepared by maritime nations for the use of their navigators are already completed and published in advance as far forward as the year 1888; and that it would be an indefensible incongruity for any Government to require one description of time reckoning to be employed in the current work of the astronomers in its service, and another in its astronomical publications covering the same period.

The committee have further reason to believe that, while there is a general disposition on the part of the astronomers of Great Britain and the United States to accept the proposed change, the feeling towards it on the continent of Europe is less favorable. It is to be hoped, and,

indeed, may be presumed, that time will remove this adverse disposition, if it exists, and that before the close of the century a harmony of opinion on the subject, which is already general, may become universal.

At the recent meeting of the international association entitled the *Astronomische Gesellschaft*, held at Geneva in August last, this question was considered and discussed at some length, but was left undecided. The discussion may be resumed hereafter, and should the conclusion be favorable the association may name a time at which the change may be everywhere simultaneously made.

The committee regard favorably the proposition of the Meridian Conference on this subject, and recommend that the change should be made as soon as sufficient concert of action can be secured among the leading astronomers and astronomical establishments of the civilized world, in 1890, if practicable; if not, in 1900.

II. The Solar Eclipse of August, 1886.

The second of the questions submitted by the Secretary inquires as to the expediency of asking Congress for an appropriation to provide for the observation of the total solar eclipse of August, 1886. Were it highly probable that, under the circumstances, observations could be secured which would be of material gain to knowledge, the committee would not hesitate to reply promptly in the affirmative. No class of celestial phenomena has furnished more valuable contributions to our knowledge of the physical condition of the sun, and of the stellar universe generally, than is afforded by these eclipses. It is this which has prompted and justified the large expenditure of time and labor which has been devoted to the preparation and dispatch of expeditions for the observation of these phenomena, when they take place, as happens frequently, on distant and inhospitable parts of the earth's surface.

The eclipse of August 29, 1886, will be total only in the torrid zone, and the path of the total phase will fall mainly in the open Atlantic Ocean, but at Benguela, on the western coast of Southern Africa, it will be observable at about three o'clock of local time in the afternoon. The hour will be very favorable to observation at that station, and provided that the hygienic and meteorological conditions prevailing there at the same time could be presumed to be equally so, it would seem to be desirable that advantage should be taken of them.

Commodore Belknap, the present Superintendent of the Naval Observatory, has kindly furnished to the committee information as to these particulars in the form of a report made to himself by Lieut. C. C. Cornwell, United States Navy, who appears to have been instructed to make inquiry in regard to them. As to the meteorological conditions, the conclusions of Lieutenant Cornwell seem to be inferences derived from observations made at Loando, about three degrees north of Benguela on the same coast, but subject to substantially the same climatic vicissitudes. He says "the foggy season extends from May till the end of August, and this is the best and most healthy time of the year for Europeans." The report gives the number of days during the month of August at which the sky was comparatively clear or not more than three-fourths overcast at the hours of 9 a. m., 12 m., and 3 p. m., for six successive years, from 1879 to 1884 inclusive; deducing the result that "the probability of good weather at 3 p. m., the time of the eclipse, is as 18 to 13," not much more than an even chance, but, it is added, "it is

to be remembered that the conditions at the end of the month are much more favorable."

As to healthfulness, Lieutenant Cornwell says:

> In conversation with Captain Crispo, of the Portuguese navy, who was for a number of years the governor of Massamedes, about three degrees south of Benguela, I gathered that it would be perfectly safe for a party to spend the month of August on the coast without danger to health, and that there was nothing to fear from wild beasts.

These statements are in great measure reassuring, if not wholly so. It would be preferable, if it were possible, to have some direct and official testimony as to the effects of a climate so generally believed to be deleterious upon natives of the temperate zone, rather than be obliged to rely in regard to a matter of so prime importance upon what appears to be merely hearsay.

Were the proposed observing station within moderate distance, the uncertainty as to favorable atmospheric conditions would be of comparatively little consequence. The question becomes more serious when the station can only be reached by a voyage extending to more than a quarter of the earth's circumference. The distance by great circle from New York to Benguela is nearly six thousand nautical or seven thousand statute miles. With any vessel likely to be assigned by the Government to the duty of transporting an observing party for this purpose, the transit could hardly be accomplished in less than a month. The selection of a site for an observing station, the erection of temporary shelters for the party, the installation of instruments, the necessary preliminary observations for latitude and longitude, and the calculation of the circumstances of the eclipse for the exact locality, all which things should be deliberately done, would occupy not less than a fortnight. So that the expedition, in order that it may have a reasonable prospect of success, should leave New York not later than the middle of July.

A doubt here presents itself whether, in case Congress should respond favorably to a request for an appropriation for this object, the action of that body would be likely to take place early enough to allow time for the proper outfit of the expedition and the necessary drill of the observers in the methods of observation to be employed. It may be necessary, and probably will be, to construct instruments for the uses of the expedition; for, though it was understood that there are telescopes at the Naval Observatory which have been employed on former similar occasions, and which may suffice for direct observation, the records of the eclipse which will have the highest value will be such as will have to be secured by photographic impressions of the successive aspects. It is impossible that the instruments employed for this purpose in the Transit of Venus expeditions may have been preserved; but even if that is the case, modifications suggested by experience, or designed to adapt the apparatus to the special objects aimed at in the present instance, will doubtless be required; for in addition to the observation of the sun itself, and the luminous phenomena attending it, it is desirable to obtain photographic maps of all the surrounding region to the distance of at least ten or fifteen degrees from the sun, for the purpose of finally setting at rest the still mooted question of an intramercurial planet. It is true that the astronomical world is at present disposed generally to discredit the existence of such a body, yet the evidence on the subject up to this time is mainly negative, as it must always continue to be so long as it depends upon direct vision. In a photographic map, taken during total eclipse of the sun, of the whole

region within which such a planet must necessarily be confined, the object, if present, must present itself, and could not fail to be recognized. But, for photographic operations of this class, lenses of wide angle must be specially prepared, differing essentially in character from those which are employed to take impressions of the eclipse.

During what is called the long session of Congress definite action is rarely secured upon any important measure until late in the spring or in the early months of the summer, and this is especially true of money bills. If an astronomical expedition is to be sent out under the auspices of the Government not later than the 15th of July, the fact ought to be certainly known as early as March at least, in order that the preparation may be made with such deliberation and thoroughness as to insure satisfactory results. Considering the usages which have seemed to govern Congressional legislation in the past, the committee are apprehensive that, even in case provision should be ultimately made for the expedition under consideration, it would come so late as to be unavailable, or would compel a preparation so imperfect and hurried as to be inadequate to accomplish satisfactorily the objects in view.

Taking all these reasons into consideration, the committee decline to recommend the application for an appropriation.

III. The Observatory.

The third of the questions submitted by the Secretary appears to the committee to possess a higher importance than attaches to either of the others. It inquires as to "the expediency of proceeding promptly with the erection of a new Naval Observatory upon the site purchased in 1880."

It is now many years since the question of the removal of the Observatory was first agitated. The board of survey, created by act of Congress in 1872, of which the Chief of Engineeers, General A. A. Humphreys, was chairman, recommended that the Observatory should be removed to a better site, adding that the sale of the grounds attached to the present building would probably furnish the means of making the necessary purchase elsewhere. As a principal reason for such removal it was stated that the present site of the Observatory will be needed for projected city improvements. The suggestion of this report produced no immediate effect; but after the accession of Admiral John Rodgers, in 1877, to the Superintendency of the Observatory, the question was revived, and the removal was earnestly pressed. In a letter addressed by Admiral Rodgers in September of the year just named to the Secretary of the Navy, it was recommended "that a suitable site north of the city and inside the District of Columbia be procured for a new Observatory," for the reasons, first, "that the malarious influences surrounding it (the present Observatory) are notorious, and that from May to about the middle of October the officers whose services are necessarily in the Observatory at night, pay the penalty in impaired health and diminished efficiency;" secondly, that "the fogs which arise from the river, driven by the prevailing winds, float above the instruments and lessen their usefulness;" and, thirdly, that "the present Observatory is in a very dilapidated condition." In support of these statements Admiral Rodgers presented the written testimony of eminent medical men residing in Washington, some of them officially attached to the naval service, and also that of several of the astronomers whose work is at the Observatory, all of whom concur in the opinion that the present site is seriously if not dangerously unhealthy. To this cause

Medical Director Clymer does not hesitate to ascribe the early death of Captain Gilliss, Superintendent of the Observatory from 1861 to 1865; and Professor Yarnall expresses the opinion that the maladies by which Professors Ferguson and Hubbard and Assistant Moses Springer were carried off were produced or fatally aggravated by the same injurious influences. It is further testified by the same authority that every family which has resided in the Observatory building has suffered more or less severely, Admiral Sands having been at one time "reduced to the edge of the grave." In like manner, the observers who, though living by day in more healthful quarters were obliged to attend at the Observatory at night, in the discharge of their regular duties, were almost without exception subject to chills and fever.

In regard to the second objection, the interference by fogs with the work of observation, the testimony is unanimous as to the fact of the evil, but is greatly conflicting as to its magnitude. Thus Professor Yarnall says:

Generally the condition of the atmosphere is favorable to observation, except in the fall, principally in September and October. We have often to stop work from the fogs which arise from the river after midnight.

Professor Hall says:

My experience is that the observations which are chiefly affected by the river fogs are those of faint objects, like comets and the small planets, when observed at a low altitude. During the summer and fall it not unfrequently happens that observations of such objects are prevented by these fogs.

Professor Harkness testifies that—

Occasionally, on an otherwise clear night, a slight mist rises from the river, but it is rarely so dense as to interfere appreciably with meridian work, although perhaps it may sometimes prove an impediment in the case of very faint objects.

Professor Eastman writes:

At intervals throughout the year, and on nearly every night from May to December, the surface of the Potomac River, in the vicinity of the Observatory, is covered, towards the latter part of the night, with a mass of vapor or fog, which rises to such a height as completely to envelope the Observatory, and is so dense as seriously to interfere with all observations of small objects.

He adds:

The heated air over the dwellings north of the Observatory seriously interferes, in the winter, with the definition of all objects within 25 degrees of the horizon, and the increase in the number of buildings in that section of the city augments the difficulty every year.

Professor Holden, after mentioning his opportunities to observe at West Point, and at the observatory of Dr. Henry Draper on the Hudson, at Hastings, continues:

My invariable experience has been that the atmospheric conditions obtaining at Washington for objects of low altitude are less favorable than those of the other observatories in question, and this I attribute almost entirely to the proximity of the Naval Observatory to the river, whose fogs and vapors exert a decidedly hurtful influence upon the astronomical work.

As to the third consideration bearing on removal, viz, the condition of the Observatory building, we have the statement of Admiral Rodgers, made in 1877, that it would require $29,909.35 to put it at that time in suitable repair. Commodore Belknap, the present Superintendent, writes, under date of October 26, 1885:

The dilapidated condition of 1877 is replaced by a still more dilapidated one in 1885. The observing rooms, except that of the transit circle, are small and ill-constructed. The dome of the great equatorial is badly warped, requiring a four-horse power engine

to move it; the surroundings of the dome are in bad repair, and the buildings generally are ill-adapted to the purpose of an observatory. The 9.6-inch equatorial room is in direct communication with the main building, and the currents of heated air which rise therefrom greatly interfere with the efficiency of the instrument.

Commodore Belknap further represents that the library, which is large and very valuable, is not properly accommodated, and that there is no suitable provision for the storage and preservation of the records. It may be added that the building is not fire-proof, and that the destruction of the library by fire would involve the loss of many priceless works which cannot be replaced.

The present building appears, moreover, to be faulty in plan. In a letter of Professor Newcomb, addressed to Admiral Rodgers in 1877, it is stated that—

> The present building is entirely inadequate to the needs of a national scientific establishment, having been built more than thirty years ago, when American astronomy was in its infancy. The large and valuable library of the Observatory is outgrowing the limits which can be provided for its accommodation, and is now housed in what was formerly an observing room, where its proper protection from the vicissitudes of the weather is hardly possible. There is no proper place to store the records of observations and calculations made during the period now including thirty-two years; and the instruments used in the observations of the late transit of Venus have mostly to be stored in a small room, where they are greatly exposed to destruction by fire. The architecture of the present building is such that it cannot be readily enlarged to meet the increasing wants of the establishment. One of the principal instruments of the Observatory (the prime vertical transit) has to remain unused, because the room in which it is placed is appropriated as a store-room and passage-way combined.

On the evidence as thus presented, the case would seem hardly to admit of doubt. The conclusion is almost forced upon us that, that whatever may be done about the erection of a new observatory, every consideration—sanitary, scientific, and economical—requires that the present site and the present structure should be abandoned.

There is something, however, to be said on the other side. The citations above given are mainly drawn from documents prepared eight years ago. The sanitary question, which is by far the most serious one, has since that time assumed a different aspect. The Observatory site has not always had the malarious character which has in recent years made it so nearly uninhabitable. It owes its unhealthiness to the formation of marshy flats, in consequence, it is said, of the obstruction to the flow of the river by the building of the Long Bridge. These flats are now in process of being rapidly filled up, and it is the belief of some of the medical men of Washington that with their reclamation the deleterious influences of which they have been the cause will cease to be exerted. Others of the profession, however, take a different view; and while authorities equally entitled to respect are thus at variance among themselves, it seems to be the duty of this committee to give a greater weight to the certainty of the present than to the possibilities of a doubtful future.

In regard to the obstruction to observation by fogs, the quotations above given, though they make the most of this difficulty, show nevertheless that it is not a matter of gravity. Professor Holden, whose opinion is perhaps the least favorable of those expressed in 1877, says now, in a letter before the committee, "the river fogs alone are not a sufficient cause for removal." Professor Newcomb, whose continuous service for sixteen years at the Observatory thoroughly familiarized him with all the advantages and disadvantages of the place, is silent on the subject; so that it may be inferred that he considers the difficulty too unimportant for mention.

As for the dilapidated state of the building, that may be a reason for repairing, or, if necessary, for reconstructing it, but it is not in itself a reason for a change of site. But if, as appears to be the case, the present site is objectionable on other and more serious grounds, the defective condition of the building deserves consideration as suggesting that the present is a favorable time for abandoning it. But at this point the question naturally arises, whether, in case a new Observatory should be erected on the site purchased in 1880, it would not be advisable to give to the new institution so erected a larger usefulness that can belong to an astronomical establishment assumed to have been designed to subserve only the wants of a single branch of the public service.

The honorable Secretary in employing the phrase "Naval Observatory," instead of saying "Observatory," merely, has seemed to submit the question, whether, in the opinion of the Academy, the interests of the *Navy* require that a new Observatory should be erected. The committee have therefore sought to ascertain what are the special services rendered by the Observatory to the Navy, or what are the relations of the establishment to that branch of the public service which justify the epithet *Naval*. This title has never been conferred upon it by law, nor is it that by which it was first known. The Observatory commenced its operations in the autumn of 1844, and its first volume of Observations was published in 1846, under the title "Astronomical Observations made during the year 1845, at the National Observatory, Washington. * * * Published by authority of the Hon. George Bancroft, Secretary of the Navy." Vol. II of the series was published in 1851, by authority of the Hon. William A. Graham, Secretary of the Navy under President Fillmore. In a letter addressed in 1854 by Lieut. M. F. Maury, then Superintendent of the Observatory, to Commodore Charles Morris, chief of the Bureau of Ordnance and Hydrography, of which a copy has been furnished to the committee by Commodore Belknap, it is stated that "the Observatory was christened 'National' by Mr. Bancroft (the first Secretary of the Navy under President Polk) in a letter of March 6, 1846, relating to the labors to be undertaken at the *National* Observatory. Its Observations (first volume) were published under that title by his authority, and not that of the Bureau."* Com-

* Vol. I of the series, published in 1846, has two title-pages, one of them in letter-press and printed as part of the first form; the other engraved, and inserted apparently afterwards. The original and regular title-page designates the Observatory as "The National Observatory"; in the one later inserted it is called "The U. S. Naval Observatory." A presentation slip inserted between the two is as follows: "Presented to ——— by the U. S. Naval Observatory, Lt. M. F. Maury, U. S. N., Superintendent." This makes it apparent that the change from *National* to *Naval* was made by Lieutenant Maury on his own responsibility. But as Vol. II, published in 1851, had also two title-pages, with the word "National" in full in both, and as the same was true of Vol. III, published in 1853, the evidence is pretty strong that this act of the Superintendent did not meet with approval of the Department. Vol. IV gave in both titles the initials "U. S. N. Observatory," which may read "National" or "Naval," at pleasure. In later volumes the engraved title disappears.

In the appropriation bill approved August 3, 1848, a clause was inserted providing that the Superintendent "shall be either a captain, a commander, or a lieutenant in the Navy;" but Lieutenant Maury did not regard this as justifying a change of title in the published Observations, and no change was made until after the ruling of Secretary Dobbin in 1854. Moreover, previously to this ruling the Observatory was referred to in the annual appropriation bills either as the "National Observatory" or the "United States Observatory," both these forms appearing in the bill approved March 3, 1855, three months after the ruling. The term "Naval Observatory" first appears in legislation in the appropriation bill approved August 16, 1856.

By a special act of Congress approved March 3, 1865, the provision of the appropriation bill of 1848 requiring that the Superintendent of the Observatory should be a naval officer was repealed.

modore Morris appears to have been dissatisfied with this state of things, and on the 11th of December, 1854, he made an appeal on the subject to the Hon. J. C. Dobbin, Secretary of the Navy under President Pierce, who promptly replied:

> My opinion is that it [the Observatory] should be styled "The United States Naval Observatory and Hydrographic Office."

Thus one Secretary overrules the decision of one of his predecessors and the practice sanctioned by two of them, and arbitrarily changes the name which has been borne by a public institution, with the perfect acquiescences of Congress and the people, for nearly ten years. Mr. Dobbin founded his ruling on the considerations that "it" (the Observatory) "has always been under the control of the Navy Department, and it is conducted by Navy officers both in its superintending and somewhat subordinate duties."

These things were, indeed, true as facts; and, indeed, there was a temporary requirement of law, introduced, in accordance with a practice by no means to be commended, into an appropriation bill, directing that the Superintendent should be a naval officer; but when Mr. Dobbin goes on to say further, "it is a Navy affair, and its reputation is the property of the Navy," he asserts what was hardly true at the time, and what in the subsequent history of the establishment has been still less so, for the reputation which the Observatory has acquired has been a reflection of the personal luster of individual men appointed to it from civil life, and whose most brilliant works have been accomplished quite independently of their routine duties at the Observatory.

The fact that the Observatory is under the control of the Navy Department does not necessarily give it the character of a naval establishment. The Museum of Hygiene is under the same Department, but it is not called a naval museum. The Marine Hospital Service is under the Treasury Department, but this is not because it has any affinity with the business of collecting and disbursing the revenues, but simply because it is seemingly proper that every branch of the public service should be subject to the control of some Executive Department. It was by a very simple series of events that the Observatory fell under the supervision of the Secretary of the Navy. Some years before the erection of the present Observatory building, there was established on Capitol Hill an office of modest pretensions, styled a "Depot of Charts and Instruments," of which the character is described in its title. Here nautical chronometers were regulated, reflecting instruments regulated and tested, and charts deposited, to be supplied, whenever needed, to our public armed vessels. After the erection of the Observatory these duties were transferred to that establishment, and while it remained in this embryonic condition there might perhaps have been a certain propriety in calling it a naval observatory; but the service it rendered to the Navy required no astronomical instrument for its satisfactory performance more than a small meridian transit. The variety of superior instruments with which the new structure was furnished invited, however, to the prosecution of researches purely scientific, and the consequence has been the publication up to this time of about thirty volumes of Observations, embracing between five and ten thousand pages, not one in a hundred of which is probably of any especial concern to the Navy.

In 1866 the charts and nautical instruments were removed from the Observatory to the Hydrographic Office in the Navy Department. The chronometers remain, and the rating of these time-pieces is the only

substantial link by which the Observatory maintains a practical connection with the naval service. Secretary Dobbin, in the order by which he transformed the name of the Observatory, making it *naval* after it had been for ten years known only as *national*, seems to rest for the justification of his proceeding on the fact that "it has always been conducted by Navy officers"—a fact, certainly, but a fact for which for several years after it was founded there existed no requirement of law, and for which there exists none now. This fact, however, is undoubtedly the principal ground on which the claim that the Observatory should be called a naval institution must rest. It has always had a naval officer, usually an officer of rank, at its head. Junior naval officers have, moreover, been frequently sent there to be trained in methods of observing, and sometimes to be charged with the duties of observers without training, or at least without adequate training. This seems, however, to be a very subordinate branch of naval education. If this were not the case, however, the fitness of things would seem to suggest that provision should be made for the training of these officers at Annapolis rather than at Washington. There is already an observatory at Annapolis, but the course of instruction pursued at the Naval School there is of itself evidence how little importance is considered in naval education to attach to the processes of practical astronomy as conducted in fixed observatories. All the astronomical training which the naval cadets receive is confined to the principles of navigation and the use of portable reflecting instruments. It is believed that the observatory of the Academy is not used at all, and has not been for many years, and the neglect of it would appear to show that the naval officers stationed there have not the time to occupy themselves with subjects so far outside of the necessities of their professional life.

But if it should appear to Congress, or to the leading minds in the naval service, that a certain number of the junior officers of the Navy ought to be familiarized with the use of fixed astronomical instruments, then propriety would appear to suggest that the educational institution which was expressly established to give to young men the knowledge of other subjects necessary to qualify them for duty in the naval service should furnish them also their proper instruction in this. Let for this purpose the observatory of the Academy, if necessary, be enlarged, and if the additional duty consequently imposed upon the present staff of instructors is likely to overtask them, let their number be increased. Let also the business of rating the chronometers be transferred from Washington to Annapolis, and then we shall have an observatory which may properly be called *naval*.

The work by which our Washington Observatory has made itself known, that which has given it the honorable reputation it enjoys, has been work which has been undertaken and successfully accomplished purely in the interest of astronomical science. It is such work as is done at Greenwich, at Pulkova, at Paris, and other national observatories. The heaviest part of this work consists of those observations of standard stars, of the planets, and of the moon, which are necessary to the perfection of the nautical ephemerides, on the accuracy of which the art of navigation and the security of the mercantile no less than of the naval marine are so entirely dependent. This is the kind of work in which the usefulness of a public observatory is most directly felt. It is the kind of work which makes the existence of public observatories a necessity, for its monotony is such as to offer no attractions to private observers, who naturally devote themselves to researches which hold out the fascinating hope of discovery.

But researches of this latter character form also a part of the work of public observatories, though they constitute no part of their necessary duties. And there can be no doubt that it is to the success of such incidental labors, when they are successful, that such institutions owe in large part the reputation they acquire. The honorable Secretary Dobbin, in 1854, claimed that even at that early day, when it had been only ten years in existence, our National Observatory had already achieved an enviable reputation—a reputation which he claimed as the property of the Navy. But at that time the institution had published but two volumes of Observations, and the reputation it had acquired was due almost wholly to the brilliant success of Professor Sears C. Walker, one of its civilian astronomers, in determining, in 1847, the orbit of the then recently discovered and distant planet Neptune. And Admiral Rodgers, in enumerating at a later day the grounds on which the Observatory may fairly claim to rank among the first institutions of its class in the world, finds nothing to say of its relation to the Navy except the following: "It co-operates with the Navy in determining positions abroad. It is the depot where the chronometers for the Navy are kept and rated, and from which naval vessels are supplied with them on being placed in commission. Its appliances are always open to officers of the Army and Navy who wish to avail themselves of them in determining positions." On the other hand, he speaks of "the furtherance of navigation" as "the legitimate work of the Observatory," this being a service of larger importance to the merchant marine than to the naval, in the proportion in which the number of ships engaged in commerce exceeds that of those created to meet the exigencies of war. And speaking further of its valuable services to the country and to science, he says, "it is in nearly constant co-operation with the Coast Survey and with the heads of exploring parties, in determining the latitudes and longitudes of cities, boundary points, and important stations in every part of the States and Territories." He adds, "All longitudes in this country are now, in the first place, determined by means of, or are referred to, this Observatory." He attributes to the Observatory credit, also, for dropping time-balls from its own dome, and in the city of New York; for lending essential aid to the American Ephemerides and Nautical Almanac by perfecting the tables, indispensable to the navigator and the astronomer; for a persistent study pursued through years of the moon's irregularities, with a view to the correction of the still outstanding errors of the lunar tables; for the Star Catalogues prepared for publication by Professor Yarnall, commended in the report of the council of the Royal Astronomical Society of London in 1874, as "a valuable contribution to observing astronomy; the catalogue containing 10,658 observed stars, and including many observed in the Army and Coast Surveys, and many from Lacaille's Catalogue not hitherto observed"; for Professor Newcomb's valuable contributions to the volumes of Observations for 1865, 1870, and 1873; for Professor Holden's interesting papers "relating to the ring Nebula in Lyra, the Trifid Nebula, the Satellite of Uranus, and other astronomical topics"; for the discovery by Professor Ferguson of Euphrosyne, the first of the planetoids discovered in this country; for the discovery by Professor Hall of the two satellites of Mars, and so on; and he shows, from the extent of space given in the German Astronomical Review, and Monthly Notices of the Royal Astronomical Society of London, to the work of our Washington Observatory as compared with others, that in the estimation of European astronomers our Observatory ranks among the first in the world. Indeed, he states that an authority so high as Father Secchi, of Rome, puts Pulkova,

Greenwich, and Washington together in the foremost rank of astronomical institutions.

The claims here made are all of them just, though in some instances it has been the merit of the individual observer of which the Observatory has enjoyed the benefit, since much of the most creditable work has been supererogatory rather than obligatory. Still it cannot be denied that it has been the Observatory which has afforded to these successful laborers the opportunity to put forth their strength, and furnished the stimulus which has animated them to effort. The honorable reputation of the institution has even been enhanced by labors undertaken by some of its observers independently of their professional duties as connected with it, and of which the results have been given to the world through different channels. This is especially true of the colossal labors of Professor Newcomb in his "Theory of Neptune" and his "Investigations of the Orbit of Uranus," published in the Smithsonian Contributions to Knowledge, and in his "Theory of the Perturbation of the Moon produced by the Planets," published in Liouville's Journal, Paris, of which it was remarked by Professor Cayley, president of the Royal Astronomical Society, that "it contains the successful development of a highly original idea, and cannot but be regarded as a great step in advance in the method of the variation of the elements, and in theoretical dynamics generally."

All these specifications, however, creditable as they are to the Observatory, are illustrations of the services it has rendered, not to the Navy, but to the art of navigation and pure astronomical science. It has served for our country the purpose on account of which the Observatory at Greenwich was avowedly founded two hundred years ago, for England, and that for which, within the present century, the Observatory at Pulkova was founded for Russia; that is to say, notwithstanding its name, its labors have been actually conducive to the common good of the nation, and have not been restricted to the special benefit of any particular branch of the public service; and such, should it be maintained, will continue to be the character of its work, whatever may be the title by which it shall be known. But that its title should be in harmony with the nature of its work would seem to be a dictate of the simplest common sense. In the view of the committee, therefore, should a new Observatory be erected, whether on the site of the present one or on that which was purchased in 1880, or anywhere else, at the cost of the Government, it should not be a Naval but a National Observatory.

Having become thus assimilated in title, as it already is in its work, to the institutions of similar character maintained by the Governments of other enlightened nations, it would seem that it should, like them, be placed under a direction in harmony with its objects. No one can have a higher respect for the gallant officers of our Navy than the members of this committee or those of the National Academy; but it implies no disrespect to them to say that there is nothing in their professional education, and nothing in the nature of their active duties in the service to familiarize them with the processes of astronomical observation or to acquaint them with the construction and uses of fixed astronomical instruments. There have been exceptional cases, indeed, in which a naval officer has been an accomplished astronomer. This was especially true in the case of Capt. J. M. Gilliss, who had the direction of the Observatory from 1861 to 1865, and of Admiral C. H. Davis, his immediate successor, who held the position from 1865 to 1867. When astronomers like these are to be found in the Navy, it is quite fitting that they should be placed at the head of our National Astronomical Observatory; but in

the view of the committee a line officer of the Navy not thus specially qualified is as much out of place as superintendent of a great astronomical establishment as a civilian astronomer would be if placed in command of a fleet of armed vessels in time of war.

There is another consideration which bears seriously upon the expediency of appointing naval officers to fill this important post, whatever may be their scientific qualifications—it is the brevity of the time during which they are permitted to enjoy this honorable distinction. The exigencies of the naval service are continually imposing upon the Department the necessity of ordering them to other fields of activity, often before they have had time to familiarize themselves with their duties in this temporary post. It is now just forty-one years since the Observatory commenced its operations, and it has had already, including the present incumbent, nine different Superintendents, of whom one was a second time appointed after an interval of seven years, making ten different administrations, and giving an average term of incumbency of four years and one-tenth. The only Superintendent who seems to have held office with anything resembling permanence was Lieutenant Maury, the first on the list, whose term of service extended from 1844 to 1861, seventeen years, and who then voluntarily abandoned his post; but Lieutenant Maury had been disabled by an accident from active service in the Navy before his appointment to the Observatory, and hence was disqualified except for some such position as that which he held in the Observatory. Deducting these seventeen years there remain twenty-four, during which there have been nine successive administrations, with an average term of service of two years and eight months. And in the list of Superintendents during this period are two who held the position for less than one year.

Now, in any human undertaking whatever, nothing can be less favorable to the attainment of satisfactory results than continual change in the directing head, and that which would be universally regarded as inadmissible in a business enterprise, seems to be still more so in an institution established and operated in the interests of exact science. The examples of foreign observatories illustrate the importance attached to this consideration in other countries. Francis Arago held the post of director of the Paris Observatory for twenty-three years; Frederick William Bessel was at the head of the Königsburg Observatory for forty years, and George Biddel Airy was Astronomer Royal at Greenwich for nearly fifty years, the term of service in the first two of these instances being ended only by death.

Upon the point now under consideration the committee have found a letter addressed to Admiral Rodgers by Professor Newcomb in 1877, in reply to the question "Whether it is more advantageous that the Superintendent should be a line officer of the Navy or a practical astronomer," which so perfectly expresses their own view that they do not hesitate to adopt it entire. Professor Newcomb says:

> I am of the opinion that the establishment should have a scientific head, for these reasons:
>
> (1) The generally recognized necessity that every office should so far as practicable be under a head professionally acquainted with its routine of business, exists here. The most important duty of the Superintendent is to see that the observations made and the work performed are those most advantageous for the objects with which the institution was founded; that the calculations are correctly made, and that harmonious co-operation is secured among the various departments. The securing of these objects requires a permanent policy, which can only be inaugurated by a scientific head. As illustrative of this view, I may cite the fact that during one-fourth the existence of the Naval Observatory the publication of the annual volume of Observations was entirely omitted, for the reason that only one or two observers made any

observations worth publishing. The most important want of national astronomy at the present time is general tables of the stars and planets corresponding to the present state of practical astronomy; and it is a want which can, in its full extent, be supplied only by a large and well-organized observatory securing the co-operation of many minds in the work of observation and calculation. I am unable to see how such a work as this can be successfully executed except under constant scientific supervision of the establishment.

(2) It seems to me that a new Observatory should be built and administered with some one or more well-defined objects in view, and that these objects should be those of the fulfillment of which science stands most in need. Scientific control in some form would, I think, at least tend to assure the public that this end was being secured, though it might be executed by a commission or a board as well as by a single person.

(3) I think that individual astronomers of talent are more secure in the recognition of their scientific claims under a head professionally interested in the advancement of science. It is a part of the law of scientific publication—unwritten, indeed, but universally recognized in the scientific world—that every man doing original work should be recognized in its publication as the author of it. But during more than half of the existence of the Naval Observatory this right was not recognized, the name of the author being either entirely suppressed or only mentioned in some other place than the title-page of the work. That this is not now the case is due solely to the liberality of yourself and of your immediate predecessors.

The committee anticipate the objection that inasmuch as the Observatory, on their own showing, has, during the forty years of its existence, enjoyed an honorable reputation, though always during the same period under the direction of a line officer of the Navy who has not himself been usually an accomplished astronomer, this experience of the past is a practical demonstration of the fact that a scientific head is not necessary to insure to such an institution the attainment of the most satisfactory results. This argument admits of being inverted or stated conversely, as thus: The experience of the past demonstrates that a body of conscientious and faithful workers in the scientific field can attain creditable results and achieve an honorable reputation in spite of the absence of an intelligent directing mind to systematize their work and to constrain them into harmonious co-operation to the attainment of a distinctly-defined common object.

The reputation of the Observatory, as has been already remarked, rests very largely upon the admirable results attained by individual civilian members of its astronomical staff in researches undertaken of their own proper motion, and not prescribed by the superintending authority, or even assigned to them by any common agreement among themselves. Such are the labors, already referred to, of Professor Walker on the orbit of Neptune, the discoveries of Professors Ferguson and Hall, the observations of Professor Holden on the nebulæ, especially the nebulæ of Orion, the admirable contributions of Professor Newcomb to the published volumes of Observations, to say nothing of the extraordinary investigations undertaken by this last-named gentleman outside of his regular work in the Observatory. But productions of this kind, however brilliant and however admirable, furnish us no evidence of the kind of system which governs the operations of the Observatory, nor even evidence that such system exists at all. They are proofs that good work is done by subordinates, but testify nothing as to the capacity of the administrative head.

Achievements like these, however, which are the results of individual endeavors, form no part of that special description of systematic work for the sake of which national observatories are necessary, and for the prosecution of which the earliest observatories were founded. At the time of the discovery of America by Christopher Columbus, the navigator had no better means of determining his place at sea but the method of dead-reckoning dependent on log and line, and the magnetic

needle. The alarm of that adventurous navigator, when he discovered that the needle was not constant in its direction, is matter of history. Previous to that time few navigators had the daring to venture far from land; but the demonstrated existence of a new continent teeming with riches stimulated frequent voyages upon the open ocean, and the perplexing "problem of the longitude," as it was called, attracted the earnest interest of every maritime people. Tempting rewards were held out to any person who should successfully solve this baffling problem. In 1598 Philip III of Spain offered to this end a reward of 1,000 crowns. The Dutch states followed with a higher offer of 10,000 florins. The British Parliament, in 1714, proposed a grand prize of £20,000 for a method which should determine the longitude at sea within 30 geographical miles; also a less prize of £15,000 for a method true within 40 miles, and another still of £10,000 for one true within 60. In 1716 France offered for a similar purpose a prize of 100,000 livres. In 1674, during the reign of Charles II of England, a method was presented to the British court for determining the longitude by means of observations of the moon's distance from fixed stars near its path—the method still known and practiced under the name of "the method of lunar distances." This plan having been submitted to Flamsteed, then the most eminent of British astronomers, was pronounced by him to be useless on account of the errors of the tables. Of astronomical tables then existing the best were those of Tycho Brahe, and the place of a ship as determined by them might possibly be in error to the enormous extent of 900 miles. It was this state of things which led to the establishment of the Royal Observatory at Greenwich, and, shortly after, of that at Paris, examples which have since been followed by the Governments of all considerable nations which have a maritime population and commerce. Of the Greenwich Observatory it has been remarked that—

> That single institution has done more for the increase of the world's wealth than would have sufficed to support at their ease all the astronomers and physicists that ever lived since the days of Hipparchus; to build and furnish all the observatories the world ever saw; to establish and endow all the universities, colleges, and schools of every grade, from highest to lowest, throughout the globe; to erect and provide for all the hospitals, almshouses, and eleemosynary institutions of every kind in all civilized lands; and to build all the churches and parsonages, as well as to defray all other expenses attendant on the support of religion in every Christian country, from the advent of our blessed Saviour down to the present hour. To make even a conjectural estimate of the true value of its service to mankind would from the nature of the case be impracticable, since the elements which must enter into such an estimate are as numerous as the endless varied articles of human consumption. It is even impossible to make a comparative estimate of the value of astronomical agency considered along with other agencies concerned in promoting the same interests, since all the improvements of art or science which tend to give increased development to commercial enterprise, and all the stimulating influences which incite men to engage or encourage to continue in commercial pursuits steal from astronomy at least half their efficiency by availing themselves of the security which that science has provided for the immense aggregate of treasure constantly afloat upon the waves.

The immense service here so emphatically described as rendered to mankind by the Greenwich Observatory has been accomplished simply by making it a possibility to find the longitude of a ship at sea by astronomical methods. And this result has been attained by so careful, systematic, and persistent observation of the more conspicuous members of the solar system, and of the principal stars in and near the zodiac, as to give to the solar, lunar, and planetary tables, and to the star catalogues, such a degree of accuracy as to permit the future aspects of the heavens to be correctly predicted. This it is which constitutes the proper essential business of a state observatory. Two centuries ago, when the first state observatories were founded, the errors

to be corrected were so enormous as to make the first steps toward this correction comparatively easy. But the process by which these great errors were eliminated has still constantly to be repeated, since the tables of celestial movements are by no means yet perfect, and the apparent places of the stars, as determined by their spherical co-ordinates, are undergoing constant though gradual change through their own proper motions and in consequence of the procession of the equinoxes. Though, therefore, navigation by the stars has been reduced to a science of extreme accuracy, it can only be maintained in that character by unwearied persistence in the same description of observations by which it was originally made so. It is accordingly the fidelity with which it follows up this species of work, and not its occasional discoveries of comets or minor planets, or its studies of curious objects like Saturn's rings or remarkable nebulæ, which is to be the test of the intelligence with which the operations of a state observatory are conducted and of the competency of the directing head.

It is consequently to the published Observations of the Observatory that we must look for the means of forming a judgment in regard to it upon these points. If we examine the series of volumes put forth by our Observatory, at first under the name of National and afterwards under that of the Naval Observatory, we shall detect features which are far from satisfactory. At first we shall notice that there occur unexplained gaps in the series, entire years passing which leave no record behind them; and, secondly, we shall observe that when observations of certain objects were actually pursued from year to year, they are not steadily continuous or uniform in frequency; also that before the installation of the transit circle in 1866, and when two instruments were necessary for the determination of the place of a star, viz, the simple transit for the right ascension and the mural circle for the declination, these two instruments appear to have been worked without preconcert on the part of observers. Sometimes stars which were observed on one day with one instrument were observed on a different day with the other. Occasionally objects which were observed for a long period of time with one of the instruments were not observed with the other at all. In reference to these points attention is called to the letter of Professor Newcomb, addressed to the chairman of the committee, which is appended to this report.

The publications of the Observatory itself, therefore, show sufficiently the absence of any preconceived plan directing its operations; and this fact is a sufficient response to the argument that it has attained an honorable reputation while under the superintendency of naval officers who were not astronomers.

It can hardly be doubted that our Observatory will continue to be maintained, whether it be perpetuated as an appendage of the naval service or raised to the dignity implied in the more honorable title of National Observatory. Our country has been too large a participator in the benefits conferred by astronomy upon navigation, and through navigation upon commerce, and through commerce upon national wealth, to permit her to repudiate the obligations under which the history of her past prosperity has laid her to this noble science, or to permit her, even in view of her own material interests, to neglect to continue the provisions by which only these benefits can be perpetuated. Nor is it conceivable that among our statesmen it can be regarded as consistent with a proper national self-respect that this enlightened Government shall fail to extend an encouraging hand to a science which for the past two centuries, all civilized and Christian peoples have vied with each other in fostering. The United States of

America outnumbers in population any modern Christian people except Russia, and at the present rate of increase, they will, in two or three decades, exceed not only in numbers, but in wealth and military strength, every other nation of the civilized world. The time is soon coming when the sails of the American Republic will cover, as they have done in years past, every sea, and her flag will fly in every accessible port. Such a nation cannot fail to do as much for the science which has made navigation possible as at least such comparatively feeble states as Spain, Portugal, and the Argentine Republic, the last named of which has recently established at its capital, Cordoba, a noble observatory, in which our accomplished countryman, Dr. B. A. Gould, has, within the past fifteen years, achieved a work of almost superhuman magnitude, and which is destined to be a perpetual monument to his masterly intellect and his energy, perseverance, and skill as an observer. We ought rather to emulate the liberality of the most powerful states, like Russia, which, at Pulkova, has reared in recent times the most splendidly equipped temple to astronomical science yet anywhere existing.

That Congress appreciates the obligation of our people towards this branch of science is manifest in the legislation of nearly half a century in regard to it; in the erection of a costly building which, though now perhaps dilapidated and otherwise inadequate to the increasing needs of science, was originally, at least, beautiful in appearance and convenient in plan; in its original equipment of instruments equal to any of their time; the provision in 1866 of a splendid transit circle, and the purchase a few years later of the great 26-inch equatorial, at the time the most powerful telescope in the world, and now surpassed by only two others; with, finally, the purchase in 1880 of a new and admirable site, free from the objections which have been found to exist to the present one, for the erection of a new and more convenient edifice. These successive acts prove that the advancement of astronomical science has been long a settled part of the policy of our national legislature, and furnish an assurance amounting to a moral certainly that if the present Observatory should be abandoned, it will only be to erect another and a better one elsewhere. It ought certainly to be a better one. If in the completeness of its provisions to secure satisfactory results it shall correspond in any degree to what the position of our people among the nations of the earth would suggest and would seem to require, it would be the most perfectly appointed establishment of its kind hitherto created, and would stand conspicuous among the monuments by which enlightened peoples signalize to surrounding nations their moral and intellectual superiority.

The necessity of abandoning the present site, suggested as probable by the Government board of survey in 1872, and recognized to-day as imperative, affords a very opportune occasion for the early realization of this noble aspiration, and for enabling our Government while carefully guarding the interests of the Navy, whether scientific or educational, to fulfill suitably the weighty obligations under which it lies to that science which has done more than any other to build up the wealth of nations. Let all those instruments in the present observatory which can be of service to the Navy, with so many of the astronomical staff as may be needed to use them, be transferred to Annapolis, and let the observatory of the Naval Academy, strengthened by these accessions, be styled the Naval Observatory. Let the remaining instruments, which will probably be the 26-inch telescope, the transit circle, and the prime vertical transit, be reserved to be installed in a new edifice to be erected

upon the site purchased in 1880, in conformity with designs prepared after consultation with the most experienced astronomers of the country, including present and former members of the astronomical staff of the Observatory itself; and let this new structure be styled the National Observatory of the United States. Precedents for the distribution of duty here proposed may be easily found, if required. Spain maintains at her capital an observatory devoted to the interests of pure astronomy, while she has another at Cadiz styled a naval observatory. Austria has an imperial royal observatory at Vienna, and a naval observatory at Pola on the Adriatic. Germany has a principal observatory at Berlin and a so-called marine observatory at Wilhelmshafen. In like manner Russia has at Pulkova the most splendidly endowed establishment for the promotion of astronomical science in the world, and a minor one for marine uses at Odessa. France also, besides her great observatory founded in the seventeenth century at Paris, has, it is believed, another at Cherbourg connected with her naval service. In all these cases it will be noticed that the naval observatory is situated in a sea-port town. The arrangement, therefore, here proposed conforms to precedent not only in principle, but also in this rather important detail.

In view of all these considerations, the committee unanimously concur in the following conclusions, viz:

(1) It is advisable to proceed promptly with the erection of a new Observatory upon the site purchased in 1880 for this purpose.

(2) It is advisable that the Observatory so erected shall be, and shall be styled, as the present Observatory was styled originally, the "National Observatory of the United States," and that it shall be under civilian administration.

(3) It is advisable that the instruments in the present Observatory, with the exception of the 26-inch telescope, the transit circle, and the prime vertical transit, shall be transferred to the observatory at Annapolis, with such members of the astronomical staff as may be required to operate them; also that such books of the library as relate chiefly to navigation shall take the same destination; the instruments above particularly specified, with the remainder of the library, being reserved as part of the equipment of the new National Observatory, to which also the remaining officers of the astronomical staff shall be assigned for duty.

(4) It is advisable that the observatory at Annapolis should be enlarged, if necessary, and adapted to subserve as effectually as possible the wants of the naval service, whether practical, scientific, or educational; that it shall be under the direction of the Department of the Navy, and shall be styled the Naval Observatory of the United States.

Appended to this report will be found documents showing the authority under which the committee has been constituted, and also a selection from those bearing upon the subjects considered which have been laid before them during their deliberations.

All of which is respectfully submitted.

F. A. P. BARNARD, *Chairman.*
A. GRAHAM BELL.
J. D. DANA.
S. P. LANGLEY.
THEODORE LYMAN.
E. C. PICKERING.
C. A. YOUNG.

COLUMBIA COLLEGE, *New York, November* 30, 1885.

APPENDIX.

Documents contained in the appendix.

No. 1.—*From the honorable the Secretary of the Navy to the president of the National Academy of Sciences.*

NAVY DEPARTMENT,
Washington, D. C., April 22, 1885.

SIR: I have the honor to submit inclosed a copy of Senate Executive Document No. 78, Forty-eighth Congress, second session, containing a letter from the Secretary of the Navy transmitting communications concerning the proposed change in the time for beginning the astronomical day, as recommended by the recent Meridian Conference.

I would respectfully request that the National Academy of Sciences take into consideration the question of adopting the proposed change in the American Ephemeris and Nautical Almanac, and other astronomical publications, and advise this Department of its views and recommendations on the subject.

I have also the honor to submit for your consideration and recommendation the following questions:

(1) As to the advisability of asking Congress to make an appropriation for the ob-

servation of the eclipse of the sun in August, 1886, to be expended by the Superintendent of the Naval Observatory under direction of the Navy Department.

(2) As to the advisability of proceeding promptly with the erection of a new Naval Observatory upon the site purchased in 1880.

Very respectfully,

W. C. WHITNEY,
Secretary of the Navy.

Prof. O. C. MARSH,
President of the National Academy of Sciences.

No. 2.—*From the president of the National Academy of Sciences, naming a committee of the National Academy of Sciences to consider the question of the Secretary.*

YALE COLLEGE,
New Haven, Conn., April 28, 1885.

DEAR SIR: I inclose herewith a copy of a communication from the Secretary of the Navy, requesting the National Academy of Sciences to take into consideration the following questions:

(1) The proposed change in the time for beginning the astronomical day, as recommended by the recent Meridian Conference.

(2) As to the advisability of asking Congress to make an appropriation for the observation of the eclipse of the sun in August, 1886.

(3) As to the advisability of proceeding promptly with the erection of a new Naval Observatory upon the site purchased in 1880.

In compliance with this request, I have appointed the following committee from the National Academy of Sciences:

President F. A. P. Barnard (chairman), Columbia College, New York.
Prof. Graham Bell, Washington, D. C.
Prof. J. D. Dana, Yale College, New Haven, Conn.
Prof. S. P. Langley, Observatory, Allegheny, Pa.
Hon. Theodore Lyman, Brookline, Mass.
Prof. E. C. Pickering, Harvard Observatory, Cambridge, Mass.
Prof. C. A. Young, Princeton Observatory, Princeton, N. J.

I have sent to each member of the committee a copy of this communication from the Secretary of the Navy, and shall transmit later some official documents bearing on the questions submitted to the Academy.

Requesting that you will send me the report of the committee not later than the first of November next,

I remain, very respectfully,

O. C. MARSH,
President of the National Academy of Sciences.

President F. A. P. BARNARD,
Columbia College, New York.

No. 3.—*From the chairman of the committee to the Hon. Secretary of the Navy.*

COLUMBIA COLLEGE,
New York, June 11, 1885.

DEAR SIR: The president of the National Academy of Sciences has appointed a committee, of which I have the honor to be chairman, to consider and report upon certain questions addressed by you to him in a communication of the 22d of April, 1885, concerning which you desire an expression of opinion of the Academy.

The most important of these relates to the advisability of proceeding promptly with the erection of a new Naval Observatory upon the site purchased in 1880.

The answer to be given to this question must very much depend upon the functions which it is desired or designed that the Observatory shall in future fulfill. Its title, *Naval Observatory*, conveys the implication that its duties and uses are to be purely practical, and such as are required for the purposes of the Navy as a branch of the public service. In the beginning this was doubtless strictly its character; for it was originally established under the name of a "Depot of Charts and Instruments," and it continued to be known by this title for several years.

Since the erection of the present Observatory, however, the scope of its operations has been much enlarged and its usefulness has consisted quite as much in its contributions to the advancement of astronomical science as in its practical services to the Navy, and, indeed, in the view of the Academy, much more. Congress seems even to have made a distinct recognition of the propriety of its application to promote scientific discovery, by appropriations for the purpose, and especially by the appropriation for the construction of the great 26-inch telescope.

If the operations of the Observatory are to be conducted hereafter, to any considerable extent, avowedly for the advancement of science no less than for the uses of the Navy, the question as to the expediency of proceeding with the erection of a new building upon the site purchased in 1880 is greatly simplified; and, in fact, that admission is sufficient to decide it; but the same admission raises at once another question which, without having been directly submitted to the Academy, is necessarily involved in that which is actually presented. This question is that of the organization of the working astronomical corps, and the direction of the operations of the Observatory.

As a branch of the naval service the Observatory has always heretofore been under the direction of a line officer of the Navy. Considered as an institution created wholly or partially for the service of science, it is obvious enough that it should be directed by a head selected with especial reference to his proficiency in the science it is intended to promote. It has happened in the past that the Department has been able to find in the naval service men of such character as astronomers as fairly to fit them for this important post. A man more competent than Captain Gilliss, for example, could hardly be found either in the naval service or among civilians. Captain Maury, Capt. C. H. Davis, afterward admiral; Capt. John Rodgers, also afterward admiral, were gentlemen admirably qualified for the same trust; but the naval service does not as a rule furnish opportunity to officers to become experts in practical astronomy; and its active duties will generally interfere a good deal in the study of astronomical theory. If, therefore, at any time the service should not be able to furnish a man whose qualifications to act as director of the Observatory should be fully recognized in the scientific world it is desirable that the Department should be at liberty to place in that responsible post a properly-qualified civilian.

It seems to be important, therefore, if Congress should be asked to make appropriations for the erection of a new Observatory on the site selected in 1880, that such legislation should at the same time be sought as should leave the Department free to choose a director either from the naval service or from civil life, as the Secretary should think best for the public interest. The committee of the Academy could only think of recommending further expenditure by the Government on behalf of the Observatory on the condition that such provision in regard to future direction should be made part of the law; but, supposing that provision secured, there can be no doubt that the committee and the entire Academy will, with one voice, advise the erection of the proposed new building. In the absence of such a provision I think they would prefer to be excused from offering any advice.

Now, my reason and my apology for addressing to you this communication is that the committee is likely to desire, before making their report, to be ascertained that their recommendation, whatever it may be, shall not be such as to affect the susceptibilities of the officers of the naval service. The Observatory is now by law a branch of the service, and it may be that such officers as are possibly in the line of advancement to the position of director may regard it as a grievance if legislation should be asked for which should remove the possibility of such promotion.

In conversation with some officers in the service I have found that this feeling does not exist, and I hope it may not be entertained by any. I have thought that you might be able to give me such information upon this point as to remove the embarrassment of the committee. I therefore respectfully solicit an expression of your opinion upon the subject as early as may be convenient.

It has been suggested that, in case the new Observatory should be built, the old one might be continued also in operation, and that a distribution of duties might be made which should give the old building entirely up to the navy with a Naval officer for director, while the new one might be confined to work strictly in behalf of science. I should be happy to be informed what view you would be disposed to take of such a proposition.

I am, sir, very respectfully, your obedient servant,

F. A. P. BARNARD,
President Columbia College, Chairman of Committee.

Hon. W. C. WHITNEY,
Secretary of the Navy.

(This letter remained unanswered.)

No. 4.—*From Commodore George E. Belknap, Superintendent of the Observatory, to the chairman of the committee.*

UNITED STATES NAVAL OBSERVATORY,
Washington, October 2, 1885.

SIR: I have the honor to inclose herewith for the information of the committee of the National Academy, of which you are chairman, some data concerning the surroundings of Benguela, Africa, on the line of totality of the eclipse of August 29, 1886.

Very respectfully,

GEO. E. BELKNAP,
Commodore, U. S. N., Superintendent.

Professor F. A. P. BARNARD,
President of Columbia College, New York.

[Inclosure in the foregoing.]

Extract from a report relative to the healthfulness and meteorological conditions of Benguela, Africa, on the line of totality of eclipse of August 29, 1886, made by Lieut. C. C. Cornwell, U. S. N., to the Superintendent of the Naval Observatory.

From the meteorological observatory at Lisbon I learned that there were no meteorological reports received from Benguela, but that those from Loando were believed to apply equally well to the former place. The foggy season extends from May till the end of August, and this is the best and most healthy time of the year for Europeans. August is the last month of the fogs at Loando, but probably the season lasts somewhat longer at Benguela.

During the season, the fog is thick in the morning, especially at sunrise. It clears away about noon, and 3 p. m. is the most favorable time for observations.

The following table gives the number of days during the month of August, for six years, and at the times indicated, that the sky was either clear, slightly cloudy, or not more than three-fourths covered:

Year.	9 a. m.	Noon.	3 p. m.	Remarks.
1879	6	5	15	Mean temperature in August during these years 193. centrigrade.
1880	5	9	9	
1881	5	9	15	
1882	12	17	21	
1883	2	5	9	
1884	3	11	19	

The probability of good weather at 3 p. m., the time of eclipse, is 18 to 13; but it is to be remembered that the conditions at the end of the month are much more favorable. There are several places in the vicinity of Benguela where an observing station may be established. Mount Sombreiro (St. Philip's Bonnet) is a headland on the coast about 6 miles from Benguela, and is 150 meters in height. There is a practicable road to this point, constructed for the use of the keepers of the lighthouse, which is situated about half way up the hill. Catumbella is a village situated on the right bank of the river of the same name, and is a place of some importance, having a fortress and being a place of resort and safety. It is about 10 miles to the northward of Benguela.

On the left bank of the river is a hill, with a house at its summit, which was formerly the residence of the military commander of the post. This would seem to be a good place to establish a station, as it is easily accessible from Benguela, being connected with it by a good road.

Lobito Bay is about 10 miles north of Catumbella, and is an excellent sea-port, but there is no easy method of reaching it except by sea. There are no houses there, and there is some difference of opinion as to there being any fresh water in the immediate vicinity. The neck of land forming the bay would seem to be a favorable place for establishing a station, providing the party were independent of the surrounding country for its food and water supply.

Mount Agulhas, which is known in Portugal as Serra das Bambas, being really a chain of mountains, is about six miles south of Benguela, on the road to the village of

Dombe. It is a sterile spot, with no water in the vicinity, which can be secured no nearer than Guipupa, and it is here of a chalybeate nature. * * *

In conversation with Captain Grispo, of the Portuguese navy, who was for a number of years governor of Massamedes, I gathered that it would be perfectly safe for a party to spend the month of August on the coast without danger to health, and that there was nothing to fear from wild beasts.

No. 5.—*From Commodore Belknap to chairman of the committee.*

UNITED STATES NAVAL OBSERVATORY,
Washington, November 6, 1885.

* * * With regard to the nomenclature of the institution, I beg to send, for your information, a copy of a letter from the Department to the Superintendent, during the administration of Mr. Pierce; also, extract from a letter written by Lieutenant Maury to Commodore Morris, in 1854, concerning the same matter.

Respectfully and sincerely yours,

GEO. E. BELKNAP.

President F. A. P. BARNARD.

No. 6 (A).—*Extract from a letter, dated December* 8, 1854, *from Lieut. M. F. Maury, Superintendent of the Observatory, to Commodore Charles Morris, chief of Bureau of Ordnance and Hydrography.*

* * * * * * *

The Observatory was christened "National" by Mr. Bancroft in a letter of March 6, 1846, relating to the labors to be undertaken at the National Observatory. Its Observations (first volume) were published under that title by his authority and not by that of the Bureau.

Respectfully,

M. F. MAURY.

Commodore CHARLES MORRIS.

No. 6 (B).—*From the honorable the Secretary of the Navy in* 1854 *to Commodore Charles Morris, chief of the Bureau of Ordnance and Hydrography.*

NAVY DEPARTMENT, *December* 12, 1854.

SIR: In reply to your letter of the 11th instant, asking some official decision upon the name by which the establishment now under the immediate superintendence of Lieut. M. F. Maury shall be designated, my opinion is that it should be styled "The United States Naval Observatory and Hydrographical Office." It has always been under the control of the Navy Department; it is conducted by Navy officers, both in its superintending and somewhat subordinate duties. It is a Navy affair, and its reputation is the property of the Navy. If it assume another name and character, the next step will be to place a civilian at its head.

I am decidedly of opinion it should retain its present character and connection with the Navy.

Very respectfully, your obedient servant,

J. C. DOBBIN.

Commodore CHAS. MORRIS,
Chief of Bureau of Ordnance and Hydrography.

No. 7.—*Letter of Commodore Belknap on the disadvantages of the present site of the Observatory.*

UNITED STATES NAVAL OBSERVATORY,
Washington, October 26, 1885.

DEAR SIR: In response to your letter of the 7th instant, concerning the erection of the new Naval Observatory, I have the honor to inclose herewith a copy of a public document issued in 1877 upon this subject. The reasons assigned in this pamphlet for the necessity of a removal seemed so cogent that Congress in 1880 appropriated the

money for the purchase of a site and the preparation of the plans of the building. The next session was a short one, and nothing was done in the matter. The succeeding year Admiral Rodgers's death caused a cessation of active efforts to obtain the necessary appropriation.

The reasons which existed in 1877 still exist; the filling in of the flats will not obviate the trouble from malaria which afflicts those who are obliged to be on the premises at night, as the marshy banks on the opposite side of the river will continue to be a fruitful source of miasma, which will be borne to the Observatory by the prevailing winds.

The dilapidated condition of 1877 is replaced by a still more dilapitated one in 1885; the observing-rooms (except that of the transit-circle) are small and ill-constructed; the dome of the great equatorial is badly warped, requiring a four horse-power engine to move it; the surroundings of the dome are in bad repair, and the buildings generally are ill-adapted for the purpose of an observatory; the 9.6 inch equatorial room is in direct communication with the main building, and the currents of heated air which rise therefrom greatly interefere with the efficiency of the instruments.

Then, too, the offices are inadequately heated, the apparatus for that purpose being of an old style and of insufficient capacity to answer the demands upon it. The library (which is becoming larger and more valuable with each succeeding year) is not properly accommodated, and there is no suitable place for the storage of the records. The efficiency of the observing force is also injured by that fact that the observers live at a distance from their instruments, and hence much less work is done than would be possible at the new site, where the plans provide for quarters within the inclosure.

The "seeing" here is also very poor, owing to the great dampness, &c.; but thirty-eight nights of 1884 were recorded as *good*, while eighty were *poor*, and on the remaining two hundred and thirty it was not clear enough for observing. This year, about the same proportion of good nights has been noted; the very good nights of a year could be counted with a single digit. It is believed that the seeing at the new site is much better.

The situation of the present buildings with reference to the surrounding neighborhood is by no means what it ought to be as regards isolation. The inclosed extract from the report of a board of experts (composed of President Barnard and Professors Rowland and Hastings) shows how great stress should be laid upon this point.

I am of opinion that the best interests of the scientific side of the institution will be decidedly subserved by its removal to the new site; the plans are all prepared, and have been submitted to the criticism of the leading scientific men of the country, and their suggestions have received due consideration. That something must be done is obvious to one who visits the present site. Your attention is respectfully called to the estimate of Admiral Rodgers for the repair of these buildings in 1877; but even then there would remain the malaria and the absence of the observers from the scene of action as hindrances to the full activity of the institution.

Very respectfully, your obedient servant,

GEO. E. BELKNAP,
Commodore, U. S. N., Superintendent.

Dr. F. A. P. BARNARD,
President of Columbia College, New York.

No. 8.*—*Extract from report made in* 1881 *to Hon. William P. Whyte, Hon. Leopold Morse, and Admiral John Rodgers, commissioners appointed under act of Congress to select a site for the erection of a new Naval Observatory.*

* * * * * * *

Before proceeding to details, it may be well to state what, in the view of the undersigned, should be the characteristics of a spot fixed on to be the site of a working observatory. Such a site should, in the first place, be located where it may command an atmosphere as steadily unobscured and as uniform in density as the general conditions of the climate will allow. It should therefore be remote from factories or clustered dwellings, which by the smoke of their fires tend to vitiate the clearness of the air. There should not be in the vicinity any large surfaces of earth unclothed with vegetation and thus exposed to be heated to excess by the direct rays of the summer's sun, and so to generate rising currents of unequal density which may distort the figure and disturb the steadiness of the images of celestial objects. For the same reason, massive architectural structures in the neighborhood must be regarded as objectionable, even though artificial fires may not be maintained in them; and on this account

* Document referred to in the foregoing.

alone public highways, if their neighborhood were not otherwise prejudicial, should be kept at as great a distance as possible.

But a still more serious objection to the vicinity of public highways is found in the tremors occasioned by vehicles rolling over them in the instruments of the observatory. This is an evil of so grave importance as to form an objection absolutely conclusive against any proposed site liable to be affected by it. Persons without experimental knowledge of the subject can have no just idea of the facility with which tremors even from causes apparently slight are transmitted through the earth. No degree of massiveness in a structure will exempt it from liability to such disturbance, for the reason that the motion is not that of the mass itself, but that of its molecules, which are successively displaced. An ordinary milk-cart in the streets of New York will often cause the chandeliers in a dwelling perceptibly to tremble. This is most strikingly the case in parts of the city where the pavements and the dwellings rest equally on an underlying rock of indefinite extent, since the rock by its elasticity transmits tremors more freely than loose sand or soft earth. It is for this reason that in the construction of an observatory the floors of the observing-rooms are not allowed to touch the piers on which the instruments rest, lest the movements of the observer himself should disturb his instrument.

An astronomical observatory ought, therefore, if possible, to be placed at a distance from all the great thoroughfares; and though such a location diminishes facility of access to it, yet, considering the purposes for which such establishments are created, there seems to be nothing objectionable in this. National observatories have not been founded by Governments simply out of the generous desire to promote the advancement of science. The motive which has prompted their erection has been far less disinterested than this, and is found in the encouragement such institutions afford to commerce by the security with which they surround navigation. It is probable that no appropriations from the public treasury of any commercial nation have ever been repaid so many thousand fold as those which have been made for the improvement of our knowledge of the positions and movements of the heavenly bodies. But the benefits thus gained are only secured by long-continued, patient, and persevering observation on the part of those who sacrifice themselves to this exhausting task. That these observers may accomplish what they aim at, and what is expected of them, therefore, it is of the highest importance that they should not be needlessly interrupted in their labors; and hence it must be accounted an advantage and not an objection to the location of an observatory that it is so far secluded as to be withdrawn from the notice of the curious multitude.

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F. A. P. BARNARD,
President of Columbia College, New York.
HENRY A. ROWLAND,
Professor of Physics in the Johns Hopkins University.
CHARLES S. HASTINGS,
Assistant Professor of Physics in the Johns Hopkins University, Baltimore.

No. 9.—*From the chairman of the committee to the Superintendent of the Naval Observatory.*

COLUMBIA COLLEGE,
New York, November 9, 1885.

DEAR SIR: Will you kindly give me information on the following points:

(1) What are the services rendered by the Observatory to the Navy which justify the title Naval Observatory? I do not mean here services to navigation, because these are beneficial to the commercial no less than to the naval marine.

(2) To what extent does the Superintendent direct the work of the observers?

(3) Is the kind of work done by each professor prescribed to him, or does he select his own kind of work?

(4) Are the professors required to report periodically, or at all, to the Superintendent?

(5) How are the observers held to the faithful discharge of their duties?

(6) By whom are the successive volumes of Observations published by the Observatory edited?

(7) What amount of their time, *i. e.*, how many nights per week, are the observers required to be on duty?

(8) Is this allotment of time prescribed by the Superintendent, or is it determined by usage?

(9) Is any record kept of the attendance or failure to attend of the observers on the nights when they are due?

By answering these questions you will confer upon me a material favor.

Sincerely yours,

F. A. P. BARNARD,
Chairman.

Commodore GEO. E. BELKNAP,
Superintendent of the Naval Observatory.

No. 10.—*Reply of the Superintendent to the foregoing.*

UNITED STATES NAVAL OBSERVATORY,
Washington, November 10, 1885.

DEAR SIR: Referring to your letter of the 9th instant, in which you ask certain questions concerning the internal economy of the Observatory, I have the honor to reply as follows:

"1. What are the services rendered by the Observatory to the Navy which justify the title Naval Observatory?"

This question is of a peculiar character, inasmuch as it presupposes the fact of a misnomer; whereas the real state of the case is that this is the title that the institution has borne during the whole of its existence, save for a very few years when, owing to a phrase in one of Mr. Bancroft's letters, it was called by a name to which it had no right, viz, "National." Two volumes of the Observations (the second and third) were published under this caption, but all the others, each under its own proper designation of the Naval Observatory. It is first of all a *naval* institution, its astronomical work being, so far as the *naval service proper* is concerned, of a purely secondary consideration. Its officers, with the exception of three observers and one computer, are commissioned in the Navy, and its work and reputation are the property of the service. Whatever has been done to advance the science of astronomy, has been at the earnest request and urging of naval line officers, as there has always been a sincere desire to give all the aid possible to this side of the work; as witness the obtaining of the great equatorial and the new transit circle, which have always been in charge of professors

What the Observatory does for the Navy, and to do which the service must always have a place, may be seen in the following résumé:

First, it rates all the chronometers that are used in the Navy, the care of which requires the services of two officers; while two more are occupied in keeping the error of the standard clock with which the chronometers are compared.

Second, it tests all chronometers that are offered for sale to the Navy. Its appliances for this work are of the very best, and the result of its competitive trials has been to advance the standard of these important instruments, upon the reliability of which so much depends.

Third, it furnished to naval stations and to branch hydrographic offices daily noon signals, by means of which the navigators of vessels can, on the eve of leaving port, obtain comparisons with the standard clock. Its appliances for this branch of the work are the best in the country, and no other institution has been able to furnish such accurate signals, nor is it likely that there will ever be a successful rival in this field.

Fourth, it drops time-balls in several ports, by which the same facilities are afforded to navigators. This service is of importance to the mercantile marine also, but it is strictly a function of the Naval Observatory, to duplicate the work of which is entirely unnecessary.

Fifth, it furnishes longitude comparisons to naval (and other) parties engaged in such work.

Sixth, it inspects all instruments used in navigation of our vessels of war before they are accepted; and it also overhauls them before they are reissued for service.

Seventh, it employs and trains naval line officers, familiarizing them with astronomical formulæ and work, thus making a reserve from which to draw in case of any outside astronomical work being required.

"(2) To what extent does the Superintendent direct the work of the observers?"

The work to be done by each officer charged with the prosecution of a certain portion is prescribed by the Superintendent after consultation with a board composed of himself, the senior professor on duty at the Observatory, and the senior line officer next in rank to the Superintendent. The suggestions of the superintendent of the Nautical Almanac are also not infrequently received and complied with.

"(3) Is the kind of work done by each professor prescribed to him, or does he select his own kind of work?"

This question is answered above.

"(4) Are the professors required to report periodically, or at all, to the Superintendent?"

Each officer charged with the prosecution of certain work is required to report each Monday morning the work that has been done by each and every person of his division.

"(5) How are the observers held to a faithful discharge of their duties?"

It is presupposed that those who are employed here, whether they are civilians or commissioned officers, are sufficiently honorable to do duty which is required of them, and the report of the officer in charge of the division affords a check upon this. The Superintendents have been loath to apply strict naval discipline to the officers on duty here, whether of the military or civil branch; but if such disciplinary methods and supervision is deemed necessary by the proper authority, it can be readily applied.

"(6) By whom are the successive volumes of Observations published by the Observatory edited?"

Each officer whose observations are published reads his own proof, and is responsible for the correctness thereof. The work as a whole (or rather the printing) is under the supervision of Professor Eastman.

"(7) What amount of their time—*i. e.*, how many nights per week—are the observers required to be on duty?"

There are four observers on the transit circle, whose duty-day begins every fourth morning, at 9 o'clock, extending to the same hour the following day. Observers who are at their posts at night are not required to be at the Observatory until after noon of the following day. Observers on the equatorials are required to be present every clear night, to prosecute their work, but much is left to their discretion for the reason given in the answer to the fifth question. The officers on the time-service with the transit instrument are required to take observations for the clock correction every evening, and in the morning when practicable.

"(9) Is any record kept of the attendance or failure to attend of the observers on the nights when they are due?"

No. School-boy requirements are not demanded of gray-headed gentlemen holding naval commissions of rank and responsible stations, and looked upon to perform the duties assigned them as observers and computers in the spirit and tenor enjoined and described in said commissions. The personal surveillance indicated in the query is quite foreign to the traditions and usages of this institution, and is repugnant to the ideas and methods of naval officers.

In conclusion, your attention is especially invited to the fact that this institution has never been recognized by law in any way except as the "Hydrographical Office," and later as the "Naval Observatory." The word "National" as applied to it occurs but once in the various appropriation bills, and that was when money was given for the purchase of the clock invented by Dr. Locke. It is the creation of the line of the Navy, its founder having been Gilliss. If the time has come when the purely scientific side of the institution has outgrown the needs of the naval service, the converse is true, namely, that the Navy has no need of it, or of the scientific staff. If the so-called scientific men of the country think that the time has come to apply to Congress for money to build a national observatory, the Navy will not stand in their way; only it will take no responsibility for it, and will be glad to see it go to another Department of the Government, and to be under purely civilian control, including professors with civilian appointments instead of naval commissions.

Very respectfully, your obedient servant,

GEO. E. BELKNAP,
Commodore, U. S. N., Superintendent.

Dr. F. A. P. BARNARD,
President of Columbia College, New York.

No. 11.—*Extracts from letters of Prof. E. S. Holden.* (A) *From a letter addressed to Prof. S. P. Langley, a member of the committee, under date of August* 10, 1885.

* * * * * * *

I will only speak of two of the questions: First, as to the universal day. I wrote Admiral Franklin a letter which is printed in an executive document, No. 78, Forty-eighth Congress, second session, and which you have seen. I have read everything that has been written on this question, and I see no reason to change the views there expressed. I ask you to read that letter, and I would now wish to add to it the expression of my individual opinion that it is not advisable to consider the change of day any further at present, as it is certain that France and Germany at least will not introduce it for many years, if at all. France will not do it for national reasons. Professors Auwers, Foerster, Tietjen, and Krueger have pronounced against it, and practically control the action of the *Astronomische Gesellschaft*, the *Berliner Jarhrbuch*, and the *Astronomische Nachrichten*.

With regard to the second question, relating to an immediate change of site of the United States Naval Observatory, I would say that I am not in favor of a change of its site now or at any time, under the present condition of the improvements to the harbor of Washington. The reasons adduced for a change have always been two, and two only: (1) the unhealthiness of the site; (2) the fogs from the river. In the printed report of Admiral Rodgers on this subject my name is attached to the report in favor of the removal, as well as that of the other professors at the Observatory at that time.

When the question was being discussed by us, I told Admiral Rodgers that I wished to add to the report as printed a clause saying that if the harbor of Washington was to be improved as then proposed by Major Twining (and since partly executed), I was not in favor of removal. If it were not to be so improved, I was in favor. Admiral Rodgers refused to add this clause, and told me I was at liberty to sign the report as it stood or to refuse to sign it. As at that time the improvements now in progress had been once rejected by Congress, I signed the report; and now regret that I did so.

It is my opinion that the health of the Observatory site will be made as good as that of the rest of Washington by these improvements, and that the river fogs alone are not a sufficient cause for removal.

They stop observations for the last half of the night during parts of two months of the year. I see no reason why the Observatory site should not be as healthy after the river is improved as the places where I lived for eight years in Washington, viz, 2137 F street, 1923 H street, and 1905 F street. None of my family were ever ill from malaria, and I myself had only two or three very slight attacks. It appears to me that if that portion of the land to be added to the city by the river improvements which lies just south of the present Observatory reservation were to be reserved for observatory purposes (allowing carriage-ways through these parts), the extension of the Observatory grounds to the south would be ample. All meridian instruments could be located on the hill near the present site, and there is sufficient room to the east and especially to the west. To the south any new equatorials or photographic instruments could find ample space.

I would advocate buying the land north of the Observatory reservation from E street to Virginia avenue. This would secure ample room for all extensions necessary, and, if desirable, quarters could be erected for the observers at this place. The cost of this land to be met by selling the Barber estate purchased for the Observatory site.

The more this plan is considered the better it will seem. I know of but one class of observations likely to be interfered with should this plan be followed. Low circumpolars would be unsteady at lower culmination. I do not regard this as a sufficient objection to its adoption. We know already that reflection observations would not be disturbed by carriage-ways over the new land to be added at the south, nor on E street.

Should the Observatory desire to go deeply into physical researches, I would advocate a branch observatory in the Sierra Nevada or in the Rocky Mountains, although much may be done at Washington.

You also ask me to give you my opinion as to the question of the "future National Observatory in its broadest form, and especially its relations to the Government Departments." Naturally this is a question upon which I have thought, and I venture to send you a memorandum which touches upon some of the points involved, though, of course, it leaves others almost equally important untouched.

It is important that the reorganization of the Observatory shall be made, if it is made, according to a plan based on the real interests of astronomical science in the United States, and not on the real or apparent interests of any Department or set of persons. The difficulties in the case which are sought to be obviated ought to be explicitly stated for two reasons:

(1) That they should be plainly understood by Congress.

(2) That the basis of the recommendations may be comprehensible.

These difficulties may be best understood by giving a brief history of the Observatory from 1845 to 1884, and here a brief account of the difficulties met with might be given.* I need not repeat this to you who are familiar with them. Among other things, *appointments* of professors of mathematics have not been made in the interests of the Observatory. *Vacancies* at the Observatory have not been filled, but the newly appointed professors have been sent to the Naval Academy in some cases against the wishes of the Naval Academy. When the law regarding examinations was in force its spirit has not been carried out, &c.

The Observatory should be called the United States *National* Observatory.

This title accurately describes its functions.

This also was the name of the Washington Observatory from 1845 to 1848.†

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* I refer you to the New York Nation, November 9, 1882.

† From 1844 to 1856 in the U. S. Statutes.

The Observatory should be made a bureau of the Interior Department, having direct relations with the Secretary. It is necessary that the Observatory should be a bureau of some one of the Government Departments for fiscal reasons.

As radical changes are necessary, it appears that these can be carried out with more success if the Observatory does not remain under the Navy Department, where a series of precedents have been established, some of which appear to be unwise, notably those relating to the filling of vacancies in the corps of professors of mathematics.

The Government Department under which the work of the Observatory naturally falls is the Interior.

The head of the Department of the Interior should be the source of power at the Observatory. As far as possible he should be guided in his official action by the recommendation of the board of visitors and of the director.

There should be a board of visitors of five members. Two of these members should be nominated by the National Academy of Sciences, through its home secretary, to the Secretary of the Interior, who should appoint the persons named. Two of the members should be appointed by the Secretary of the Interior. The four members thus selected should elect one more member. Each member of the board of visitors should hold office for five years from the date of appointment, in general.

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No. 11 (B).—*From Prof. E. S. Holden to the chairman of the committee, under date October 17, 1885.*

* * * As you ask my opinion on the various points, I shall take the liberty of speaking frankly and fully.

(1) The Secretary has asked the opinion of the Academy "as to the expediency of proceeding promptly with the erection of a new Naval Observatory on the site purchased in 1880." I am decidedly of the opinion that this change is unnecessary and unwise (see my letter of August 10, p. 2). I believe the land from E street to Virginia avenue and between Twenty-third and Twenty-fifth streets should be bought, and the Barber estate sold to pay for it, and the Observatory grounds extended south to the river.

As to whether your committee could properly add any suggestions as to reorganization, if I were a member of the committee my voice would be for answering the Secretary's requisitions exactly, and then for stating that in the view of the committee other matters were, in fact, though perhaps not in form, so closely allied that it felt obliged to cover the whole ground, leaving the Secretary to use it or not, as he might think best.

For example, his question is, "Shall the Observatory be moved?" Suppose the committee to favor a removal *and* a reorganization, it is quite conceivable that it might object to a removal *without* reorganization.

(2) I think the Secretary would transmit to Congress any report you might submit.

(3) I should, if I were a member of the committee, advocate the plan that seemed best from a scientific point of view, without any fear but that *in the end* it would prevail. In that case the Academy would have the honor of having early proposed the first solution.

(4) I do not believe that the Observatory owes its tenure of life to the impression that it is essential to the naval service. I have every confidence that Congress would support it liberally for its intrinsic worth. If this is not the case, then it might well be allowed to die. Its present condition was a discredit. But I feel sure that Congress will gladly support any worthy observatory or any worthy scientific department of the Government.

The *Government* Observatory certainly has a function which no private (or college) observatory can fulfill. This function is to make, promptly reduce, and promptly publish observations of the principal fixed stars, of the sun, moon, and major planets.

The fixed stars are those named fundamental (some 600) and the lists of stars used for zenith telescope latitudes, &c., by the Government surveys of the Coast Survey, Land Office, Geological Survey, &c. The moon is observed at Washington *alone*, owing to the labor. The sun is observed (regularly) at Washington *alone*, and so with the planets. Harvard College, Williams College, Washington, and this observatory *alone*, make regular observations for star positions.

The primary work of the Naval Observatory is and should be regular, systematic, and intelligent meridian observations. These require a transit circle and three observers, and should be promptly published by means of a corps of from six to ten computers.

The work of large equatorials is of primary scientific importance but of quite a secondary value in the organization of a national observatory; this is at least my view.

There is, however, no question but that Government Observatories *must* do work which private establishments cannot undertake. It is simply a matter of income. Dr. Gould in South America had (at a Government observatory) $40,000 per year, and (by immense efforts also) did work which *twenty* private observatories on $4,000 a year could not do.

The worst drudgery of the profession must be done at national observatories where the income is sufficient to provide computers and observers and to divide the labor. * * *.

With regard to the universal day I have spoken in my letter of August 10. The *Astronomische Gesellschaft* as a whole seems to be against its present adoption. Certainly Auwers, Krueger, Foerster, and Tietjen are.

I have expressed my personal opinion very fully and frankly, as your letter seemed to demand, and I ask you to be sure that it is founded (with regard to the Observatory) on a reflection upon the cause of the ills they suffer. I do not believe that any simple remedy, such as appointing any special civilian, will cure those ills. I believe that its whole nature ought to be changed.

No. 11 (C).—*From a letter addressed to the chairman of the committee, under date of October 29, 1885.*

* * * * * * * *

The condition of the buildings is essentially as stated.

But the facts recited show that a new Observatory should be built *there*, not elsewhere.

The present site, when improved and enlarged as I suggest, will give ample room for observers' quarters at places where such quarters will not interfere (by smoke) with observations. * * * I do not believe that the architect's plan of the proposed Naval Observatory, as adopted by Admiral Rodgers and the advisers (myself among them), would receive the unqualified approval of competent astronomers. It would be idle to go into details in this regard, but the best modern observatories, Potsdam, Strasburg, Mount Hamilton, and others, are built on different, and I think, better principles.

The Naval Observatory should be rebuilt so as to make it *by far* the best observatory in America, or in the world.

No. 12.—*From the chairman of the committee to Prof. Simon Newcomb.*

COLUMBIA COLLEGE,
New York, November 14, 1885.

DEAR SIR: The committee of the National Academy of Sciences, appointed to consider the question submitted to the Academy by the honorable the Secretary of the Navy in regard to the expediency of proceeding to erect a new Naval Observatory on the site purchased in 1880, desire to obtain from you replies to the following questions, to wit:

(1) How long were you connected with the Naval Observatory as an observer?

(2) During this period did you personally suffer in health from exposure to the malarious influences said to prevail on and about the Observatory site?

(3) Were you aware of the occurrence of such suffering in health on the part of any of your colleagues or among the members of the family residing in the Observatory building?

(4) Were observations at the Observatory seriously interrupted by fogs rising from the Potomac River?

(5) Do the published volumes of Observations made at the Observatory show a steadily continuous prosecution of the kind of work most proper for a National Observatory, to wit, the observation of standard stars, of the planets, and of the moon?

(6) Do the same observations give evidence of a consistent direction controlling and co-ordinating the work of the several observers to the accomplishment of the most satisfactory results in the advancement of astronomical science?

(7) Does it appear to you probable that the work of a great astronomical observatory can be carried on advantageously under the direction of a superintendent not himself an experienced astronomer?

Early replies to these questions will be gratefully received by the committee.

Respectfully, yours,

F. A. P. BARNARD,
Chairman.

Prof. SIMON NEWCOMB,
Superintendent of the American Ephemeris.

No. 13.—*Reply of Professor Newcomb to the foregoing.*

WASHINGTON, D. C., *November* 17, 1885.

SIR: I have the honor to submit the following answers to the questions propounded me in your communication of November 14. For perspicuity I quote e : o

(1) How long were you connected with the Naval Observatory as an observer?

I was attached to the Observatory from 1861 until 1877. But from 1870 until 1873, as well as from 1875 to 1877, I made no regular observations.

(2) During this period did you personally suffer in health from exposure to the malarious influences said to prevail on or about the Observatory site?

I cannot say that I personally suffered greatly in health from the cause alluded to. I had occasional malarial attacks, but they were no worse than before my connection with the Observatory.

(3) Were you aware of the occurrence of such suffering in health on the part of any of your colleagues or among the members of the family residing in the Observatory building?

Nearly all my colleagues suffered so much from malaria that I could not doubt that they were exposed to noxious influences. But I never was able to decide to my own entire satisfaction how far these things were due to the site itself, and how far to the defective condition of the building and its surroundings.

(4) Were observations at the Observatory seriously interrupted by fogs arising from the Potomac River?

During the spring and autumn the Observatory was frequently enveloped in fogs, especially after midnight. But I never had any accurate data for deciding whether these fogs were merely local or whether they enveloped the whole District. A decision of this question would require simultaneous observations from some point outside of the city, and these, so far as I am aware, were never made. There is no doubt that the city around the Observatory was frequently enveloped in vapor when the heights north of it were free. At the same time I sometimes noticed that the Observatory hill was free from vapor, while the region around it was enveloped.

(5) Do the published volumes of Observations made at the Observatory show a steadily continuous prosecution of the kind of work most proper for a national observatory, to wit, the observations of standard stars, of the planets, and of the moon?

The published volumes do not seem to me to show a steadily continuous prosecution of work. Reviewing these volumes, and considering, first, the observations of the sun, moon, and planets with the meridian instruments, we find that a valuable series of such observations was commenced in the year 1846. After a couple of years, however, they began gradually to fall off without any apparent reason, and after 1848 became so few and sporadic as to be entirely devoid of value. This state of things continued until September, 1861, when there was a sudden revival of activity in this direction. This continued until 1870, when the number gradually fell off to perhaps one-half that of 1866. This state of things continued until 1881, the date of the last published volume of Observations. During the years 1865–'78 the late Professor Yarnal prepared a valuable catalogue of stars from observations with the older instruments of the Observatory. With this exception the observations of the fixed stars show the same want of continuity as in the case of the planets.

(6) Do the same observations give evidence of a consistent direction controlling and co-ordinating the work of the seveal observers to the accomplishment of the most satisfactory results for the advancement of astronomical science?

So far as the observations give evidence, no such control or co-ordination has ever existed except in one or two exceptional cases. Out of the numerous instances to illustrate this I may select one or two. Since 1875 it would seem that no attempt has been made to determine the right ascension of the standard stars of the Ephemeris. The reason for this I do not officially know, but it seems that the clock used for the transit-circle observations has been running too badly to admit of such determinations. The natural inference would seem to be that there is no authority whose business it is to see that officer in charge of the instruments is supplied with a clock of the first class.

Previous to 1865 a complete determination of the position of a star or planet required the use of two instruments, the transit for determining its right ascension and the mural circle for determining its declination. Hence in order to make any complete determination of the position, the observers with these instruments should select the same stars or planets. But the observations show that no such concert ever existed. On some days observations were made with one instrument, and on other days with the other. Sometimes during a whole year planets which were observed with the one instrument were wholly neglected with the other. Only in exceptional cases was the same star observed with both instruments during any one year.

(7) Does it appear to you probable that the work of a great astronomical observatory can be carried on advantageously under the direction of a superintendent not himself an experienced astronomer?

This depends upon the nature and objects of the establishment. If its working force consisted wholly of eminent astronomers, each of whom was expected to do his own work in his own way, without guidance or direction from any superior authority, then the superintendent would not need to be an astronomer.

But I do not consider that such work is that most appropriate to a national observatory. The latter should principally occupy itself with work requiring the long-continued co-operation of a body of obsevers, working on a well-prepared plan. To suppose that such a body could and would devise and execute such a plan without a managing head thoroughly skilled in the work seems to me contrary to all the business experience of the world in organization.

It would, in fact, be like supposing that a body of highly-skilled ship-builders could and would build a successful ship without plans and without other direction than that of a controller of expenditure.

Very respectfully, your obedient servant,

SIMON NEWCOMB.

President F. A. P. BARNARD,
Chairman Committee National Academy of Sciences.

No. 14.—*Remarks of the Superintendent of the Naval Observatory on Professor Newcomb's letter.*

So far as regards the personal experience or opinion of Professor Newcomb as to the existence or effects of malaria, comment is unnecessary, as President Barnard has before him a mass of evidence upon this point.

Attention is drawn to the fact that the Observatory is *naval* and not *national*, except in so far as the Navy itself is a national organization, it having been created by Congress many years ago as a part of the naval establishment at the solicitation of naval officers. Its first duties are *naval* and not *astronomical*, except as the latter bear directly upon the former. It began its existence with a plan of work which was good in itself, as Professor Newcomb states, but which it was impossible to carry out, for various reasons, the chief one being the great difficulty in obtaining observers, the corps of professors in the Navy not being able to furnish them in sufficient number. In addition, it may be considered as an ideal state of things where two men of equal age and upon an equal footing (with no military ideas of subordination) can engage in work upon two instruments, with but one clock and one chrongraph between them, and have everything go smoothly and without jealousy. The abandonment of the too ambitious programme first laid down was a matter of necessity, which it is probable no one regretted more than the Superintendent.

In 1866, the first year of its use, a great effort was made to obtain as many observations as possible with the transit circle. The number of observations of the sun, moon, and planets grew less from year to year, until in 1869 and 1870 they fell below the average of the later years. Professor Newcomb was in charge of the transit circle from 1866 to 1870 most of the time, and, it is understood, claimed to have been made sick by his close attention to observing. While Professor Newcomb may not have been *officially* informed of the reason for omitting the determination of corrections to the places of standard stars, he has been told why the work was discontinued, and the performance of the clock was not the principal reason. The change was made by the officer in charge of the transit circle, with the approval of the Superintendent, and after consultation with other astronomers, because with four observers, with personal equations varying with circumstances, and with the large and constantly increasing list of miscellaneous stars whose places were needed, it was considered impossible to obtain satisfactory results.

So far as the superintendency is concerned, the comparison made by Professor Newcomb between astronomers and ship-builders is illogical; "skilled ship builders" *could* make and carry out plans, and astronomers could do the same.

The managing head of the Navy Department is a civilian.

The Department, in its various ramifications and wide scope of operations, demands as much intelligence, experience, and knowledge in special lines for its successful administration as is or can be required in astronomical research of whatever character.

The Secretary himself is not a naval expert, but through the knowledge and experience of naval officers he not only manages and controls all the work and operations of the Department, but advises the President in other matters of general import in the conduct of the General Government.

He is at this moment not only building new ships, but getting up plans for others to be built in the near future; and for such purpose has to depend upon naval and civilian designers and experts to furnish the plans and data to enable him to do the work intelligently.

A like relation may be said to exist between the Superintendent and the different officers, naval and civilian, in their varied duties in carrying on the work of the Observatory, and the work of the Superintendent is largely administrative as well as directive.

It is also submitted that personal equation cannot be eliminated from the personnel of any organization, and thus there is no good reason for believing that a civilian director could manage the affairs of the institution to any better advantage or in any more harmonious degree than now obtains here.

No. 15.—*From Dr. M. F. Gunnell, Surgeon-General, U. S. N., to the chairman of the committee.*

NAVY DEPARTMENT,
Washington, November 20, 1885.

DEAR SIR: I have to acknowledge the receipt of your note of the 18th, with inquiry concerning the effect of the filling in of the Potomac flats upon the healthfulness of the site of the Naval Observatory.

I do not think there is any doubt that the filling in of the north bank of the river will be of immediate advantage to the Observatory, situated just above it.

This filling, however, has not yet been extended to the south bank of the Potomac; and for a distance of two miles along that shore, in a line south-southwest from the Observatory, in the direction of the summer winds, there are marshes exposed at low water which must continue to have some influence on the health of those engaged in making observations at night.

Respectfully, yours,

F. M. GUNNELL.

Dr. F. A. P. BARNARD,
President Columbia College.

No. 16.—*From Dr. James E. Morgan to the chairman of the committee.*

WASHINGTON, D. C., *November* 21, 1885.

DEAR SIR: In answer to your letter of the 18th instant, soliciting my opinion "as to the possible effect of filling in the Potomac flats upon the healthfulness of the site of the National Observatory" has been delayed by my absence from the city. There can be no doubt that the filling of the flats and other improvements to the harbor of Washington now in progress will greatly aid in ridding the vicinity of the Observatory of malaria, and may remove it entirely. It has been stated by good authority that malaria cannot cross a body of water of any considerable breadth. The Potomac River in front of the Observatory is probably over half a mile wide and should therefore act as a barrier to the malaria from the Virginia shore, provided the before-mentioned statement is true. Now, if the flats on the Washington side are filled and the lowlands in the vicinity of the Observatory drained and filled up it would seem that all cause of malaria would be removed.

In connection with this subject I should mention the fact that the city of Washington during the past summer has been almost entirely exempt from malarial disease. Whether this exemption is due to the partial filling of the flats or to other causes I am unable to state.

Very respectfully, yours,

JAMES E. MORGAN, M. D.

Prof. F. A. P. BARNARD,
President Columbia College.

No. 17.—*From Dr. J. S. Billings, Assistant Surgeon-General, United States Army, to the chairman of the committee.*

WASHINGTON, D. C., *November* 18, 1885.

DEAR DR. BARNARD: In accordance with your request, I have investigated the matter of the sanitary prospects of the present Naval Observatory. I have consulted with the engineer in charge of the improvements in the vicinity with regard to what is proposed to be done. I have examined personally the locality of the works actually in progress, and have investigated, so far as available data would permit, the relative prevalence of malarial disease on the Observatory grounds and in the vicinity

as compared with the rest of the city. As the result of this investigation I am of the opinion—

(1) That the malarial influences acting at the Observatory are about the same that they have been for the last ten years, and that they are much stronger there than in other parts of the city. Those who actually do the work of observing, and are at the Observatory nights, and the attendants and watchmen about the place, suffer more or less from the malarial influence. Those who have been there a long time have become, as it were, acclimated, and are less affected than new-comers; but during the months of August, September, and October it is a matter of ordinary prudence to keep away from the Observatory during the night time.

(2) The work of filling and dredging which has been going on in the vicinity does not appear to have had any decided influence as yet upon the healthfulness of the place. The filled flats lying to the south and east of the Observatory present at present most favorable conditions for malarial poisoning, and unless they are covered with a fresh layer of earth before next summer, it is probable they will give rise to much malaria. These flats, however, have probably never been an important source of malarial affections on the Observatory ground, owing to the direction of the prevailing winds during the autumn months, which is from the southwest and southwest by south, coming from across the extensive marshes on the opposite side of the river, which at this point is comparatively narrow. The contemplated scheme of improvements now being carried out does not include any work on the marshes on the opposite side of the river, and so long as these remain, I am of opinion that the Observatory will continue to be a decidedly unhealthy spot.

I do not, therefore, think that the proposed improvements in filling the flats will have any marked effect on the sanitary condition of the Observatory, except perhaps to make it a little more unhealthy than usual for the next two or three years, after which the conditions will probably be about what they are at present.

Very respectfully and truly, yours,

JOHN S. BILLINGS.

President F. A. P. BARNARD.

No. 18.—*From Dr. D. R. Hagner to the chairman of the committee.*

WASHINGTON, D. C., *November* 20, 1885.

DEAR SIR: Yours of the 18th instant has been received. In reply to your inquiry as "to the probable effect of filling in the Potomac flats upon the healthfulness of the site of the Naval Observatory," I suppose you refer to the present location of that building, and not the site for the new Observatory on the heights of Georgetown. Since the advancement of the work on the flats there has already been a marked change in the prevalence as well as gravity of malarial disease in that section of the city. From the position, however, of the present Observatory, I am inclined to think that unless the Virginia shores and the low grounds in front of the Arlington Cemetery and the so-called Mason's Island are reclaimed, the southern, southwestern, and western winds will still bring the malarial poison to this part of the city. If these improvements were made I am inclined to think there could be no objection to the present location on the score of health. As far as the present work of reclaiming the flats has gone, everything has been done that could be desired, and it is the earnest hope of all interested in the health and improvement of the national capital that this noble undertaking may be rapidly pushed to completion. I would state that the proposed site for the new Observatory in regard to health is all that could be desired.

Respectfully, yours,

D. R. HAGNER.

No. 19.—*From Dr. William Lee to the chairman of the committee.*

WASHINGTON, D. C., *November* 28, 1885.

DEAR SIR: Your letter, dated November 21, is before me. Recognizing the importance of the question regarding the healthfulness of the site of the Naval Observatory, and the high position of the committee which you represent, I was at first undecided as to whether you desired a full and detailed answer to your question, or simply my general opinion as a practicing physician. I took steps at once with the first object in view, but soon learned that Dr. Billings, of the United States Army, had already furnished you with information respecting the nature of the work being done at the Observatory site, the character of the soil, vegetation, prevailing winds, temperature, &c., so I deem it superfluous in me to say anything on those points.

As a practicing physician I would say that my practice for twenty years past had been in the neighborhood of the Observatory. Of late years I have had comparatively little practice in that locality, but I was at one time physician to the poor, and

in that position was very familiar with the locality, which is occupied almost entirely by negroes and what they call "poor whites."

The locality has always been a center for malarial diseases, and the recent turning up of the soil and deposit of loam in places with rank and decaying vegetation have increased their prevalence. This is my opinion from observation and from conversation with my colleagues, especially the present physician to the poor, Dr. R. A. Neale, who reports his cases to the health officer of the District, Dr. Smith Townshend. That answer applies to the present influence of the filling of the Potomac flats.

The probable influence of the work when completed, assuming that the work is to be done thoroughly and in accordance with sanitary requirements of a suitable subsoil drainage, paving, or asphalting to some extent, and the planting of trees properly, &c., must render the Observatory site less unhealthy.

This, I presume, answers your categorical question, but I would say further that this work once completed, the Observatory site would still be influenced, and positively so, by the large tracts of marsh land lying on the south shore of the Potomac, from whence come prevailing winds during the malarial season, as being the first high and prominent piece of land to be reached by them. Moreover, much remains to be done to the east, and in the immediate neighborhood of the Observatory site (say a couple of squares or less), to reclaim land and build on what now consists of large stagnant pools of water in a clayey soil.

Hoping that I have answered your questions as fully as was expected of me, and being ready to give you any additional information you may desire,

I remain, yours, respectfully,

WILLIAM LEE.

President F. A. P. BARNARD,
Columbia College.

No. 20.—*From Dr. T. J. Turner to the chairman of the committee.*

WASHINGTON, D. C., *November* 27, 1885.

DEAR SIR: I have the honor to acknowledge the reception of your note of the 21st instant, requesting my opinion as to the probable effect of the filling in of the Potomac flats, now going on, upon the healthfulness of the site of the Naval Observatory, on E street, in this city.

The immediate effect of filling in the flats so as to raise the land level above the tidal influence in the Potomac River will depend upon the amount of vegetable organic matter undergoing retrogressive change that may exist in the soil used to raise such land level above said tidal influence. With decaying vegetable matter associated with heat and moisture, all the factors for the production of the class of diseases known as malarial are likely to occur. The iteration of the above statement has become a maxim in the etiology of such diseases, although the involution of the values of the three terms has not been well made out. The facts upon which this opinion is based are the common property of my profession, and can be found in most of the treatises upon malarial fever since Lancisi's time.

I am of opinion, therefore, that the immediate effect would be an increase in the malarial diseases of the said locality, the more especially as the prevalent winds (SW.) would carry the "malaria" directly over the Observatory.

As to the remote effect of filling up the flats, my own observations lead me to state that the influence is in the direction of a more healthful condition.

Time is to be considered in this, and the lesser or greater length of time necessary to arrive at such condition will depend of course upon the slowness or rapidity of the destruction of the organic matter in the soil used in the filling up. I use the term "destruction" in the sense of molecular change in the organic structure.

Briefly, then, for I have no desire to extend this note beyond the facts and opinions that I have—

(1) The immediate effect will, in probability, be an increase in the malarial diseases of the locality.

(2) The remote effect will, in like manner, be a decrease in such malarial diseases, and consequently a more healthy condition of the Observatory attachés.

I have not here considered this matter from any other standpoint than that presented in your note. Other sanitary consideration being eliminated, much of the reasoning upon the facts of the origin of malarial diseases has been after the "*post hoc, ergo propter hoc*" variety, but such as it is it has been accepted.

I am, Professor Barnard, with great respect, very truly, yours,

T. J. TURNER,
Medical Director, U. S. N.

President BARNARD,
Columbia College.